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CHAPTER I.
INTRODUCTION

A. STUDY NEED AND PURPOSE

Clark County is one of Washington's fastest-growing counties. Figures from the Office of Financial Management show that the county's population grew by 35 percent from 1990 to 1998. Nearly 1 out of 10 new Washington residents over the last eight years lives in Clark County. A corresponding proportional investment in expanding transportation system capacity has not occurred. The result of fast-paced growth and slow transportation system investment is a loss of mobility for people and goods due to increasing levels of traffic congestion.

A high-occupancy-vehicle (HOV) program can improve overall mobility in the most congested parts of our region by increasing the people-moving efficiency and capacity of freeways and arterials. Integration of the HOV program with land use goals, transit operations and the development of high capacity transit facilities will also provide incentives for people to choose higher occupancy modes of travel. To date, the Clark County region has no regionally adopted HOV policies or program to develop HOV facilities.

The purpose of this study is to develop a High Occupancy Vehicle region-wide system plan for Clark County that defines policies and objectives, identifies the need and benefits, and identifies the location of possible corridors and/or facilities. The study will be coordinated with the county's and cities' land use plans and transportation elements. The relationship of planned HOV projects in the region with this study will also be explored. Coordination with C-TRAN's Transit Development Program and WSDOT's HOV Policy and State Highway System Plan will also take place. Bi-state issues affecting the HOV Study will be coordinated with ODOT and Metro. These issues include the I-5 and I-205 capacity reconnaissance being conducted by ODOT and I-5 North pricing alternatives for the Traffic Relief Options Study. This study will also be coordinated with other regional transportation study activities currently under consideration, such as the I-5 Capacity Study and the Commuter Rail Study.

Study phases include:

- Define overall approach for regional HOV development including the objectives of an HOV system for Clark County
- Identify transportation corridors for evaluation
- Examine low cost short term HOV improvements that could be implemented to provide immediate mobility improvements
- Conduct screening process to determine viable or potential HOV corridors
- Determine types of HOV facilities for consideration in Clark County
- Develop alternatives for viable HOV corridors
- Evaluate alternatives
- Recommend HOV system alternatives for implementation including the staging of corridors

B. SCOPE

1. Define Objectives, Study Management and Citizen Outreach

<u>Review and Define HOV Policies and Objectives</u> - Review State and Federal Policies regarding HOV, determine consistency of HOV policies with local land use plans. Determine the transportation objectives for HOV facilities in

Clark County such as encouraging mode split shift, transit and carpool use, managing congestion, improving transit mobility, increasing corridor capacity, improving travel flow or others. Compare HOV objectives with the regional transportation goals contained in the Metropolitan Transportation Plan, transit policies and comprehensive land use plans. Identify transportation problems in Clark County and the bi-state corridors that HOV facilities are intended to address such as recurring congestion, traffic bottlenecks, incident management or others. Identify fundamental issues critical to successful HOV facilities such as the level of recurring congestion and the nature of commute patterns and distances.

2. Data Collection, Development, and Methodologies

Develop Criteria for HOV Corridor Evaluation - Two tiers of evaluation criteria will be developed for assessing HOV corridors. Screening criteria will be used to identify corridors and facilities that have HOV potential. These criteria will be primarily qualitative or will consist of readily available information. Where applicable, separate criteria will be developed for arterial HOV evaluation. Screening criteria will include the identification of thresholds for HOV viability such as: travel time savings, congestion levels, trip distance and travel demand in the corridor, and travel demand and trip densities between residential origins and activity centers, and physical characteristics of the roadway under consideration. The second tier of evaluation criteria will consist of more detailed quantitative data and will be used to assess viable HOV corridors identified through the screening process. The criteria will identify transportation impacts, provide an operational assessment, address design considerations, and other factors. They will also help determine the range of HOV concepts and design treatments that may be appropriate for Clark County and the types of HOV to be considered in each corridor.

Data Collection and Development - This task will have two elements: research and compilation. The first element will be to research and gather information to identify factors conducive to HOV utilization such as congestion levels, optimal trip distances, transit demand thresholds, travel time savings, etc. The second element will be to compile base and forecast data for potential HOV corridors including directional travel flows, trip length, travel time, average speed, vehicle occupancy, origin/destination data, trip density, and potential HOV travel sheds. Additional base data would include existing transit and rideshare demand in the corridor, the location, degree, and duration of congestion, the location, duration and cause of bottlenecks, and existing corridor design characteristics and cross sections.

Conduct Initial Screening and Identify Viable HOV Corridors for Further Study - Conduct preliminary assessment of corridors on the regional transportation system using screening criteria developed in previous task. Screening will include the determination of viability for both freeway and arterial HOV facilities for carpooling and transit usage. Viability thresholds and criteria will be compared with available transportation data and other qualitative information to assess the potential HOV corridors and identify corridors for further study. The remaining candidate HOV corridors will meet viability thresholds developed earlier including, adequate travel time savings, sufficient travel demand, and reasonable potential for successful implementation and operation.

Travel Model Enhancement and Development of HOV Analysis Techniques - Research and review literature, coordinate with other agencies and jurisdictions on the most up-to-date techniques and procedures for transportation model simulation of HOV facilities. Development and update of the RTC travel forecasting model would include the following:

- Network simulation of HOV facilities

- Determine diversion (primary and secondary) of existing carpools to HOV facilities
- Forecasting modal shift to HOV facilities of drive alone trips to both shared ride and transit
- Assignment of demand and previous shared ride demand onto network
- Assessing the impact of HOV on the non-HOV system
- Evaluating the impact of HOV on air quality and energy consumption

Other analysis procedures and off-model methodologies will also be used to complement the travel model enhancements that do not address the factors listed above.

3. Develop and Evaluate Alternatives and Recommend HOV System Plan

Develop HOV Alternatives - Develop viable system alternatives for candidate corridors. Using factors based on research from the data collection task, identify appropriate HOV treatment and types for consideration in each viable corridor. Each alternative will include design and operational components. The range of potential HOV facilities for both auto and transit include:

- For freeway HOV facilities: concurrent, contra-flow, movable barrier, queue bypass, reversible and barrier separated facilities
- For arterial HOV facilities: bus only, right lane, middle lane, and contraflow facilities

Alternatives definition of the design components will include facility type and design, and access/egress locations. Operational components include enforcement, hours of operation, occupancy and vehicle eligibility, shared use versus exclusive use, and support facilities and programs.

Evaluation of Alternatives - Conduct evaluation of HOV alternatives and develop information for the following factors:

- Design considerations including WSDOT design guidelines
- Transportation model impacts - use of facility by auto and transit vehicles, speed, travel time, congestion, mobility, vehicle and person throughput, capacity improvements, air quality, impacts to adjacent road system
- Operational assessment - integration with other transportation system elements, system accessibility, enforcement
- Environmental impacts and issues including energy consumption and air quality
- Design issues
- Support facilities and programs such as carpool programs, park and ride lots, and incident management
- The role of transit as a modal component of HOV facilities
- Coordination with bi-state activities
- Long term use of the corridor
- Administration responsibilities
- Financing issues such as types of funding available, capital and operational costs

Recommend HOV System Alternatives - Recommend a comprehensive HOV system plan for Clark County of proposed HOV corridors, phasing of proposed corridors, design (type and treatment), and a cost estimate for the plan.

C. STUDY PROCESS

1. Organizational Structure

Figure 1-1 depicts the decision-making structure for this study and the primary participating agencies is shown below. With the exception of the Citizen Stakeholders Committee (CSC), the existing regional transportation decision-making process will be utilized for this study. The next section describes public agency roles and responsibilities. The following section describes the purpose, responsibilities, and membership and appointment process for the Citizen Stakeholders Committee.

a) RTC Board

The RTC Board of Directors will also be the Joint Regional Policy Committee (JRPC) for this project. The State of Washington High Capacity Act (RCW 81.104.030) requires that

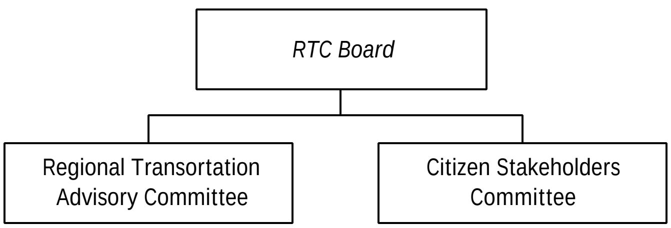


Figure 1-1: Decision Structure

a Joint Regional Policy Committee be established in order to utilize state high capacity transit planning funds. The purpose of the JRPC is to oversee HCT planning activities for this project and to ensure that the process is consistent with the requirements of RCW 81.104.100 regarding the HCT planning process.

The RTC Board will be briefed throughout the study process, and at a minimum, at critical decision stages shown in the table below. The Board will consider input from RTAC and the CSC in their decision-making process. They will provide overall policy direction and will be responsible for approving or modifying project scope and adopting recommendations resulting from the study.

Table 1-1: Study Decision Stages

Study Decision Stages
Overall Study Approach and Objectives
Selection of Corridors for Further Evaluation
Description of HOV Alternatives
Results of HOV Alternatives Evaluation
HOV System Plan Recommendations

b) Regional Transportation Advisory Committee

All activities requiring action or policy recommendations by the RTC Board will first be presented to the RTAC for their comment and support prior to action by the Board. In addition, RTAC will be briefed on project status throughout the course of the study and at the completion of each of the major study phases.

c) Jurisdictional Responsibilities

Overall study review and comment by local jurisdictions will occur through the Regional Transportation Advisory Committee. Individual jurisdictions, comprised mainly of City of Vancouver, Clark County, C-TRAN, and Washington State DOT, will be asked to assist in providing information and performance of tasks needed for specific study activities. Examples include providing corridor design characteristics and cross-sections for potential HOV facilities or assisting in the development of assumptions for bus service improvements in HOV corridors. In addition to RTAC review, RTC will be seeking feedback from the major study participants on other specific items during the study.

2. Citizen Stakeholders Committee

a) Appointment Process and Membership

The Citizen Stakeholders Committee was made up of twelve members which included ten neighborhood representatives and two business representatives. Neighborhood representatives were selected based on a defined number of representatives from each area and on the number of households within that area. In addition, based on Board discussion, one representative was selected from Skamania County.

The process for the selection of both neighborhood and business representatives was initiated by sending letters to neighborhood associations, business associations, and chamber of commerce organizations within Clark County requesting candidates for consideration on the CSC. The correspondence will describe the scope and purpose of the HOV Study, time commitment, meeting frequency, and the purpose and responsibilities of the stakeholders.

One goal in assembling the committee is that it be reflective of potential users of an HOV facility and should include commuters that use a variety of travel modes to a variety of destinations. In order to accomplish this, a follow up letter to interested candidates was sent asking candidates to include a brief profile describing which major transportation facilities they use on a regular basis, if they commute, whether they go by car, carpool, or bus, and if they work in Clark County or Oregon. This process helped in appointing a committee with neighborhood and business perspectives, but also is reflective of Clark County commuters.

Based on a review of candidate names received from neighborhoods and business associations by RTC staff, with the assistance of Vancouver, Clark County, C-TRAN, and the Washington State Department of Transportation, the RTC Board selected the following people to serve on the High Occupancy Vehicle Citizen Stakeholders Committee. Committee members and their affiliation are shown in Table 1-2.

Table 1-2: Citizen Stakeholders Committee Members

Name and Representation Area	Neighborhood
Jonathan E. Frederick Clay Wheeler *North County*	Mt. Vista Ridgefield Junction
Bill Woodward Ernie Goodrich *Central Vancouver*	Lincoln West Hazel Dell
Chuck Stemple Shareefah Abdullah *East Vancouver*	Cascade Park Civic Assoc. North Garrison Heights
Hal Seeds John Wilson *East County*	Northview NHA Village at Fisher's Landing
Dean Walker *Skamania County*	Skamania Community Council
Catherine Rich-Daniels George Laing *Businesses*	Vancouver Chamber Clark Public Utilities

b) Role

Implementation of a successful HOV facility is, to a large part, dependent on its acceptance and use by the general public. The Citizen Stakeholders Committee is intended to provide the foundation to ensure that the community's questions and comments are considered during the study. The initial input from the community occurred through the CSC. It provided a citizen perspective to decision-makers in the consideration, planning, and potential implementation of HOV facilities in Clark County.

The CSC will provide comment to agency staff and recommendations to the RTC Board at critical junctures through the process to ensure that recommended HOV facilities and priorities reflect the needs and desires of the community. As an HOV system plan is developed in the later stages of the study, the CSC will comment and provide guidance to staff and on public outreach strategies to engage the larger community of what role HOV facilities should have in the region.

c) Mission Statement of the HOV Study

Determine how a high occupancy vehicle transportation program can improve mobility in the most congested parts of the region. The study will develop a regional High Occupancy Vehicle system plan for Clark County that:

- Identifies the needs and benefits of high occupancy vehicle transportation in the Clark County region
- Describes the locations of possible HOV corridors and facilities
- Defines regional high occupancy vehicle policies and objectives
- Identifies changes to the Metropolitan Transportation Plan and the city and county plans needed to incorporate HOV study results

D. How the HOV System Plan was Developed

Figure 1-2 illustrates the process leading to the development of the Clark County HOV System Plan.

Introduction to HOV facilities provided information on what HOV facilities are, how they work, types of facilities, their potential benefits and examples of HOV systems in other regions.

Background travel information was presented to the Committee to familiarize them with travel characteristics for Clark County and for bi-state travel. It included information on transportation related growth, travel patterns and system performance.

Candidate transportation corridors were identified for both freeways and arterials. The candidate corridors were then evaluated to determine which facilities warranted more detailed study. Two separate approaches were used for the evaluation of freeway and arterial facilities.

The Washington State Department of Transportation HOV goals and policies were reviewed and used as the starting point for the development of HOV goals and policies for the Clark County region.

The development of goals and policies for a Clark County HOV System resulted in HOV goals for the regional system, freeway HOV policies and operating policies, and arterial HOV policies.

Freeway facilities were evaluated using screening criteria and selected for detailed study.

The evaluation of candidate freeway corridors was conducted by comparing 2017 travel data with the screening criteria and ranking the freeway corridors based on the comparison.

The development of freeway HOV alternatives was based on the evaluation and ranking. It identified HOV lanes and ramp bypass treatments for the alternatives.

The evaluation of freeway HOV alternatives consisted of developing 2017 travel forecast information for the HOV options that included information on transportation system performance, traffic operations, and cost and financing. The evaluation was used to finalize the HOV system plan.

Arterial corridors were screened using more qualitative process and consisted of flagging arterial locations that met specific travel characteristics for congestion and bus volumes.

The evaluation of candidate arterial corridors was based on the process described above. The 2017 travel forecast of auto congestion, bus service, and transit demand on the arterial system was reviewed and used as the basis to develop arterial HOV alternatives. The arterial alternatives were then fed into the HOV system plan.

The recommended HOV system plan was developed by combining the freeway and arterial corridor alternatives. Support facilities and operating characteristics are also identified.

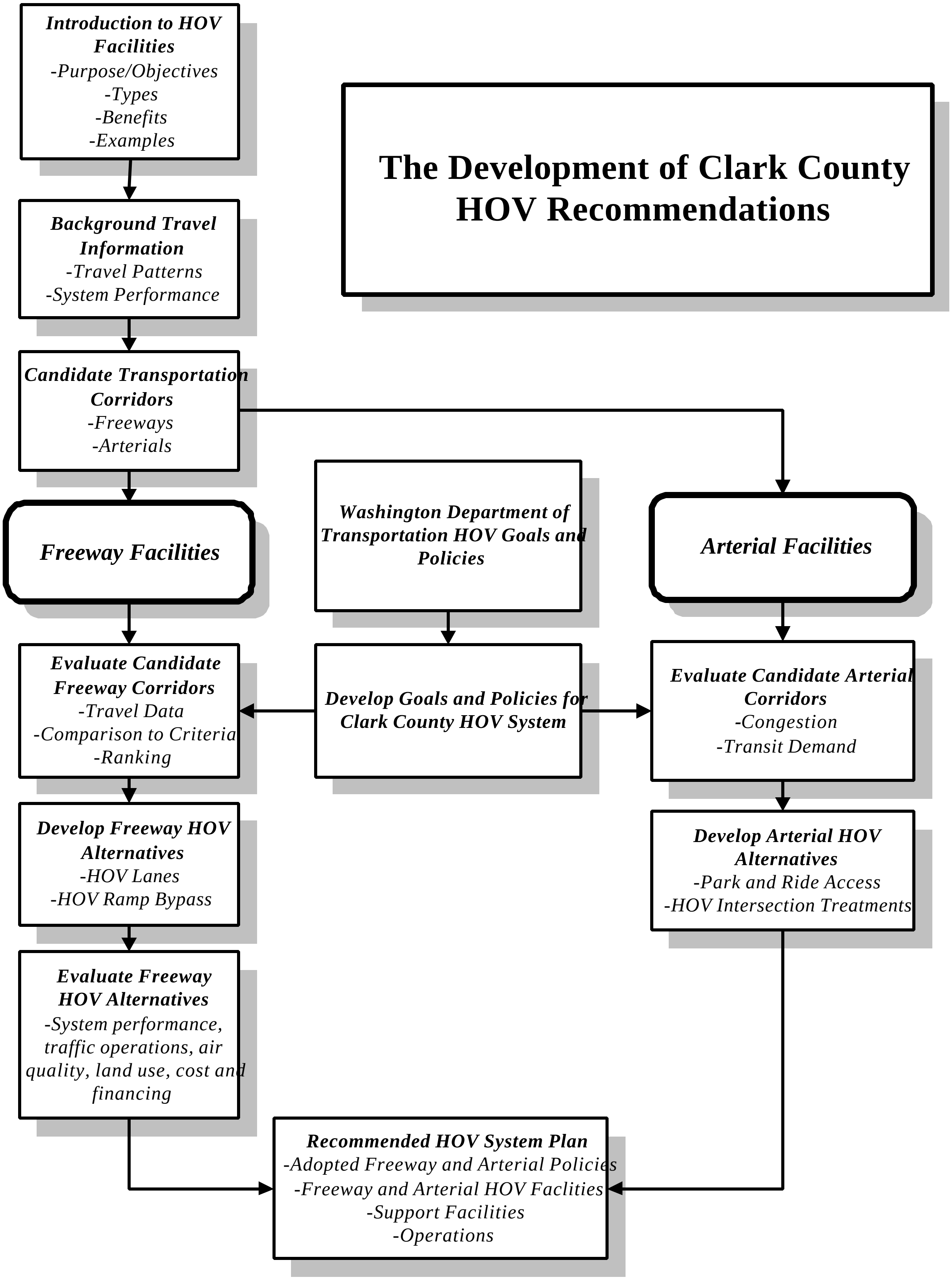


Figure 1-2: The Development of the Clark County HOV System Plan

CHAPTER II.
PRIMER ON HIGH OCCUPANCY VEHICLE FACILITIES

This chapter provides background on HOV facilities. It describes the purpose and objectives of HOV facilities and the types of HOV facilities for freeways and arterials. Section C provides information of the differences in function and use of freeway and arterial facilities. Section D describes how various areas of the country have applied and used HOV facilities in their regions. They have each developed particular HOV strategies to address transportation mobility. The last section of this chapter identifies common factors from different parts of the country that have been found to result in successful HOV implementation.

A. THE PURPOSE AND OBJECTIVES OF HOV

Generally, regions throughout the country have implemented HOV facilities for a variety of reasons. The Puget Sound region, for example, has built HOV lanes "to reduce delays for highway users who use more efficient travel modes…" and "to preserve people-moving capacity into the future with a minimum of new highway construction." The Houston region has moved toward an HOV/Busway system to "effectively and cost-efficiently promote ridesharing for commuters."

HOV facilities provide preferential treatment for vehicles carrying more than one person and can include carpools, vanpools, and buses. HOV facilities emphasize person movement rather than vehicle movement. They can offer the user significant travel time reduction compared to travel in a general purpose traffic lane. In addition, HOV facilities have high reliability and predictability compared to general purpose travel lanes. They operate at a significantly better level of service and because most are designed to include their own breakdown/enforcement areas, are less prone to delays due to incidents.

The reasons that regions have chosen HOV as strategy are numerous. Although areas like Puget Sound and Houston each have unique reasons for their commitment to HOV as part of their transportation systems, there are common themes that emerge. One is to improve mode shift by reducing drive alone trips and provide travel incentives for shared ride trips. Another is to increase the person carrying capacity of the transportation system and highway corridor. This is done by converting general-purpose capacity for HOV use or by the provision of new highway capacity for only shared ride use.

Many regions feel that the need to increase highway vehicle carrying capacity of the transportation system can be reduced or deferred by implementing an HOV strategy that can get more out of the existing system. In the case of general purpose lane conversion to HOV use, there is the potential to move more people through a corridor without a major capital investment. There are other HOV approaches that do not take general-purpose capacity, but instead add HOV capacity.

In addition, the goal of reducing or deferring the need for highway capacity may be accomplished by adding capacity for HOV only and not necessarily by converting general purpose to HOV use. The implementation of HOV capacity, whether by lane conversion or added capacity, allows better and more effective management of travel demand compared to general purpose capacity.

The public agency responsible for the HOV facility, in coordination with stakeholders and the public, can manage the demand, operation and use of the facility by defining occupancy requirements, its hours of operation and other factors. Some areas, such as Houston, Texas, whose HOV system is described in Section C, have implemented pricing in conjunction with the HOV designation to fine tune the demand, maximize use, and ensure a high level of operation of the facility. General purpose travel lanes do not have the flexibility to do this.

HOV facilities can improve the efficiency and economy of public transit. By providing effective, reliable and high grade travel speeds for the transit system, the public transit operator has many potential benefits. It can increase carrying capacity with the same number service hours by reducing the need to add buses to meet schedules, and it can attract more riders by providing faster and more reliable travel times.

HOV facilities can reduce fuel consumption by moving more people in fewer vehicles at better travel speeds. In conjunction with improved transit service, these factors can have a positive impact on air quality within the region.

B. Types of HOV Facilities

There are many different types and treatments for HOV facilities. This section describes the primary types of HOV facilities that have been used and are in use throughout the country. The list is not intended to be all inclusive, but to provide an idea of the physical characteristics and nature of the different types of facilities. A description of the operational differences between freeway and arterial facilities is described in Section C.

1. Freeways

a) Interim HOV Lane

Interim HOV facilities are usually intended to be a temporary treatment. They are usually placed with the existing ROW on the freeway shoulder or through the conversion of a general purpose travel lane and separated from the general purpose travel lanes by a painted stripe. They can be located on the inside or outside shoulder of a freeway facility. Many times an interim facility will revert to general purpose traffic use during the off-peak period.

Figure 2-1: Interim HOV Lane

b) Concurrent HOV Lane

A concurrent HOV facility is a permanent treatment. It can be separated by a paint stripe or more typically, by a two to four foot at-grade buffer from the general purpose traffic. Since there is no barrier, concurrent HOV lanes can be accessed at any point to and from the adjacent general purpose travel lane. When there is a wide buffer separation, there are usually marked locations where vehicles are allowed to enter and exit the HOV lane.

Figure 2-2: Concurrent HOV Lane

c) Ramp HOV Bypass

HOV ramp bypass treatments are located at freeway entrances and provide priority access for carpools, vanpools, and buses onto the freeway system. Normally, a freeway ramp with this treatment will have two lanes: one lane, for drive alone vehicles, would be metered at a traffic signal controlling access to the freeway the other lane is designated for carpools only and allows shared ride users to jump the queue past the metered vehicles.

Figure 2-3: HOV Ramp Bypass

d) Barrier Separated HOV Lane

Barrier separated facilities are divided from the general purpose traffic lanes by a concrete barrier. Access to the facility is only at designated locations. Because of the physical separation from the general purpose traffic, barrier separated lanes generally have a higher degree of reliability than concurrent lanes. This type of facility may be used as an exclusive busway or may consist of a mix of HOV and bus vehicles. Barrier separated lanes may be concurrent flow with one lane of travel in each direction, or like the Houston system can consist of a single lane as a reversible flow facility.

Figure 2-4: Barrier Separated HOV Lane

e) Contraflow HOV Lane

A contraflow facility is a peak direction only facility. Underused off-peak direction capacity is converted to peak direction use during the commute period. Movable pylons or barriers are used to convert the off peak direction general purpose travel lane for HOV peak direction use. When not used as an HOV lane, pylons may be removed or barriers placed against the inside freeway median so the lane can revert to general purpose traffic use.

Figure 2-5: Contraflow HOV Lane

2. Arterials

The primary purpose of arterial HOV treatments is to improve bus flows and maximize transit reliability.

a) Signal Priority for Buses

Signal priority for buses allows the transit operator of a bus, when the bus is in mixed flow traffic, to activate the traffic signal as the bus approaches an intersection to provide green time to allow the bus to travel through the intersection with minimum delay. Traffic on the side streets of the intersection approaches may experience some additional delay as a result.

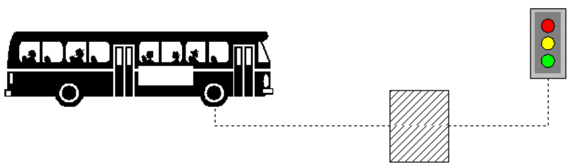


Figure 2-6: Signal Priority

b) Right-Side Lane HOV

Right side lane HOV consists of an outside lane dedicated for use by bus and carpools only. The lane can be more or less restrictive. Strict limitations of use by carpools and buses usually occur only on limited access arterials where access to local businesses is not an issue. The common approach for arterial HOV lanes is to allow SOV use of the HOV lane only for access into businesses and right turns at intersections. This treatment allows HOVs and buses to continue through an intersection, but requires a right turn for drive alone vehicles.

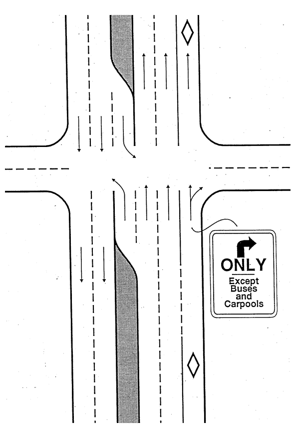


Figure 2-7: Right Side Lane HOV

c) Signal Queue Jump

Signal queue for buses and HOV is similar to signal priority in that the driver or bus activates the green time. Unlike signal priority, buses and HOV vehicles are separated from the mixed flow traffic approaching the intersection, usually on the outside traffic lane that is designated for carpool and buses only. The green time allows buses/HOV to go through the intersection ahead of the drive alone vehicles.

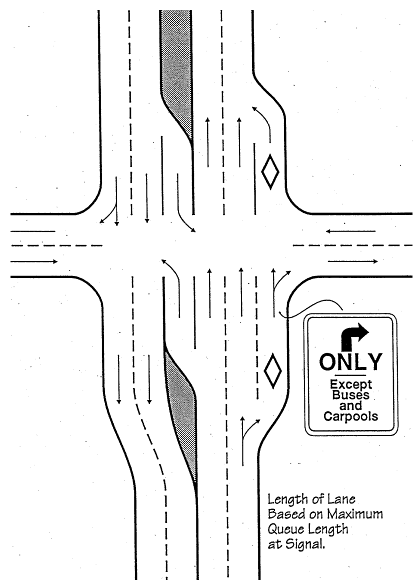


Figure 2-8: Signal Queue Jump

d) Bus Priority and Turnout

This is a variation of the signal queue jump except that a bus pullout is located upstream of an intersection. The driver can activate the signal behind it to hold oncoming traffic and allow the bus access into the general purpose traffic lane prior to the mixed flow traffic. It clears downstream traffic for easy access into the general purpose traffic lane. Unlike the signal queue jump, this treatment is used only for buses.

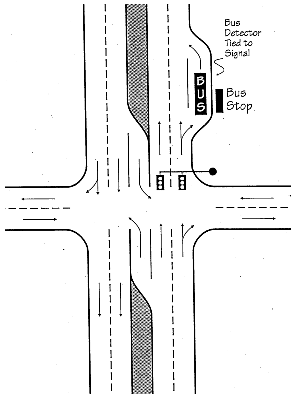


Figure 2-9: Bus Priority and Turnout

e) Preferential Gating

This is also similar to the signal queue jump, but it occurs at mid block instead of at an intersection. The driver of a bus can hold mixed flow traffic adjacent to the bus pullout by activating red time and allow buses to merge back into the general purpose traffic lane.

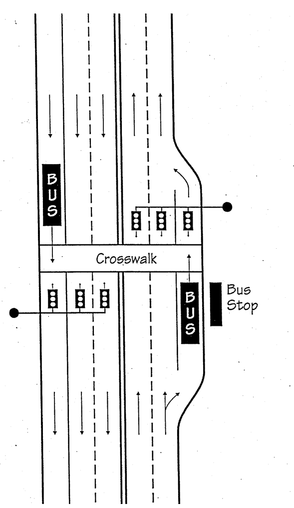


Figure 2-10: Preferential Gating

C. HOV Operations and Applications

This section describes the differences between the application and use of HOV lanes for freeway and arterial facilities. For bus travel both freeway and arterial facilities can offer some benefit. Freeway HOV facilities are intended to serve the longer distance commute trip for both carpool and transit markets. Congestion and delay along a freeway facility can be the result of a specific bottleneck or of congestion along the length of a corridor, and the treatments of HOV focus on the length of the corridor. Most arterial HOV treatments focus on addressing locations along a corridor where there is a high degree of bus delay.

In addition, freeway HOV strategies generally benefit all shared ride users, carpools, vanpool and buses. Arterial facilities, because of the different travel market they serve, focus primarily on promoting transit reliability and improved bus flows.

Unlike freeway HOV facilities, arterial HOV facilities will not generally encourage a shift to carpooling. They cannot offer the same degree of travel time savings as freeway HOV due to the shorter trip length and the shorter distance traveled along the arterial. Arterial delays overall are usually the result of high congestion levels at specific intersections, not along the facility.

Since most arterial treatments involve providing priority for buses, the consideration of arterial HOV must balance the need to minimize bus delay and improve reliability with the need to maintain adequate traffic operations.

The following table provides a brief summary of some of the differences between freeway and arterial HOV.

Table 2-1: HOV Applications and Operations

Freeways	Arterials
Focus is along a corridor except for ramp bypass	Focus is at specific locations along a corridor
Benefits carpools, vanpools, and buses	Benefits primarily buses with some secondary benefit to carpools/vanpools
Can offer significant and predictable travel time savings and better reliability for all shared ride users	Can offer more reliability and less delay for buses
Longer trip lengths and greater travel time savings	Shorter trip length and less travel time savings results in less attractiveness for carpoolers
Can promote and improve shared ride use	Does little to improve shared ride use
Emphasis on person movement, not vehicle movement	Emphasis on the efficient movement of buses and people
HOV freeway facilities can reduce the delay resulting from accidents because of the greater degree of segregation between HOV and mixed flow traffic	There is no discernible safety difference between arterial HOV and non-HOV facilities

D. HOV Experiences in Other Communities

As mentioned earlier in this report, regions who have made a commitment to HOV strategies for their communities have taken a wide range of approaches. The first part of this section has a brief overview on potential capacity of an HOV facility to move people through a corridor based on experiences from other parts of the country. Parts two and three provide some discussion of two regions, Puget Sound and Houston, that have a strong and continuing commitment to HOV systems. There is no single solution and there is also great variety in what works within different communities.

Part four of this section provides a description of two short term HOV demonstration projects that have occurred within the bi-state region in the last several years: the Banfield HOV demonstration project and the I-5 Trunnion Repair Project in September of 1997 which included an HOV strategy in the I-5 and I-205 HOV corridors.

The last part of this section contains a summary of discussion at the October 29, 1997 meeting of the Citizen Stakeholders Committee. The Committee shared their own experiences with HOV and the factors they have found that make them successful or unsuccessful.

1. Person Capacity

The person capacity of a freeway HOV lane has a wide range of capacity depending on mix of buses, vanpools, and carpools in the lane. Route 495 in New Jersey is an express bus only lane and carries up to 34,000 people per hour. During peak use the facility carries 725 buses per hour or 12 buses per minute. Route 55 in Orange County carries primarily carpool vehicles and moves 4,000 people during the peak commute hour in about 1,700 vehicles with an average of almost 2.3 people per vehicle. By comparison, a typical general purpose freeway lane operating at a good level of service (LOS C) will carry about 1,800 vehicles per hour and 1,980 people. The Shirley Highway in Washington, DC carries 9,200 people per hour per lane compared to 2,500 in the adjacent general purpose travel lane.

2. The Seattle HOV System

The first HOV facility in the Puget Sound region was implemented 1979 on I-5 north of downtown Seattle as a bus only facility. It was expanded to include carpools a year later. Limited planning went into that facility, but the WSDOT took advantage of the opportunity to assess the potential of HOV in the corridor. Like many regions in the country, Seattle has experienced fast growth that has overwhelmed its ability to provide enough increase in general purpose capacity.

The magnitude and degree of traffic congestion in the Puget Sound area is legendary, and the region began a strategy to provide incentives for people to use alternate travel modes by offering reduced delays to carpools, vanpools, and buses through the provision of HOV lanes.

After a small beginning, Seattle has expanded and continues their strong commitment to an HOV system. The Puget Sound region currently has 135 lane miles of HOV facilities in place and their HOV system plan identifies an addition of 170 miles over the next twenty years as funding becomes available. By comparison, Clark County has a total of 19 freeway miles within the urbanized area and 31 miles county wide. In addition, WSDOT has developed a list of HOV capital projects in the Puget Sound region to provide greater separation between the HOV and general purpose travel lanes in highly congested segments of the freeway system.

The Puget Sound HOV system is made up of both radial and circumferential freeway corridors. I-5 goes north and south through Seattle, I-90 runs east and west across Lake Washington, I-405 bypass east of Seattle goes east of Lake Washington near Bellevue, SR-520 is east and west across Lake Washington, and SR-167 is located east of and parallel to I-5 south Seattle. Figure 2-11 shows the existing HOV system in the Puget Sound region.

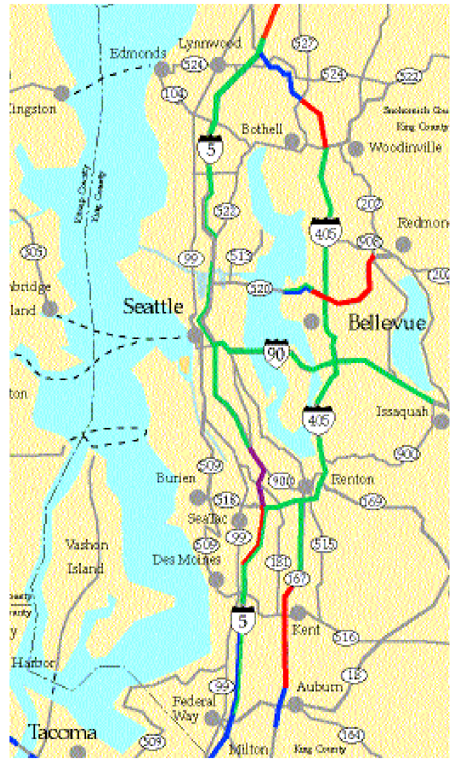


Figure 2-11: Puget Sound HOV System

<u>HOV System Operations</u> – Most of the HOV System is concurrent HOV and is located along the inside median of the freeway. I-405 is an outside HOV lane, although the long range system plan calls for the eventual conversion to inside lane. Lanes are in operation 24 hours a day and have a two or more person occupancy requirement. The only facility in the region with a 3 person occupancy requirement is SR-520. The HOV lane is located on the outside shoulder and must merge left with general purpose traffic at the bridge head crossing Lake Washington. The three person requirement was instituted because of safety concerns that the 2+ requirement resulted in too many vehicles using the HOV lane for a safe merge to the general purpose traffic.

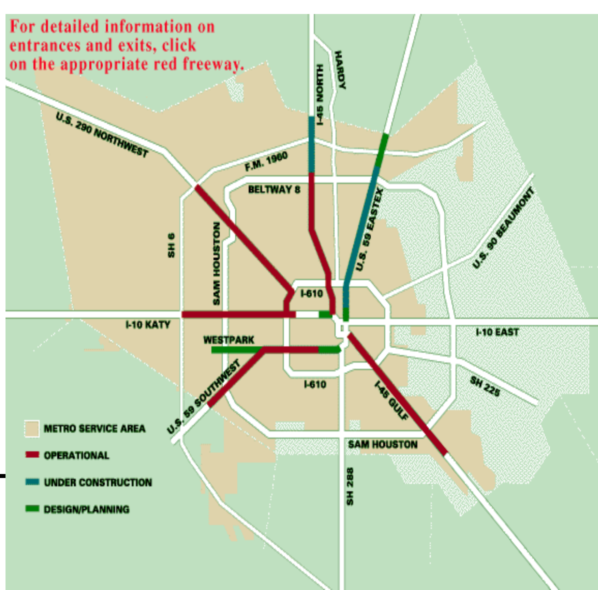
State Policy for the Puget Sound region states that lanes must operate at a speed of 45 m.p.h. or better for 90% of peak hours. If that standard is not met, the occupancy requirements may be increased. In addition, the system is supported by an extensive network of park and ride lots with more than 27,000 spaces in the region as well as extensive commuter transit service. The highest volume HOV corridor is located on I-5 north of Seattle. It carries 6,200 people per hour during the morning commute and is made up of half bus riders and half carpools/vanpools.

3. The Houston HOV System

Like Puget Sound, the Houston, Texas region also has a strong commitment to HOV. They have an extensive network of HOV facilities but have taken a very different approach in the type and operation of facilities that have been developed. The Houston HOV system is made up of barrier separated reversible lanes that operate during the peak period. Buses, carpools and vanpools are allowed to use the lanes which carry 35,000 vehicles and 80,000 people a day. The average speed of the mixed flow traffic lanes in the HOV corridors is 24 m.p.h. while the average speed in the HOV lanes is between 50 and 55 m.p.h., which offers a very high grade, reliable trip for shared ride users. The Houston Metro transit authority has calculated that the 5 HOV lanes carry the same volume of passengers as 19 freeway lanes. The entire HOV system is made up of radial corridors connecting central Houston with outlying suburbs. Houston currently has 71 lane miles of HOV. Since it is a single lane reversible lane system, it is roughly equivalent to Seattle which has 135 lane miles of two-way concurrent HOV lanes In addition, the system calls for the addition of another 40 miles of HOV by the end of the decade. Figure 2-12 shows the existing HOV system in the Houston region.

HOV System Operations – The barrier separated reversible lane HOV system operates inbound to downtown Houston in the morning and outbound in the afternoon. The lanes are in operation from 5 a.m. to 11 a.m. in the morning and from 2 p.m. to 8 p.m. in the afternoon. Most of the system has a two or

Figure 2-12: Houston Area HOV System



more person occupancy requirement. In the late 1980’s, I-10, the Katy Freeway, was changed to a three person requirement for the AM one hour and PM one hour peak periods due to congestion in the HOV lane. Katy Freeway is also the highest volume corridor on the system. Prior to the implementation of the High Occupancy Toll Pilot Project (described below), it carried almost 3,600 persons during the peak hour compared to 1,150 persons in the adjacent general purpose travel lane. In addition, the Houston HOV system is supported by 24 park and ride lots adjacent to the HOV network and express transit service into the Houston central business district.

Houston High Occupancy Toll Pilot Program - After the Katy Freeway was changed from a 2+ to 3+ requirement during the directional one hour commute period, HOV volumes on the facility during that period dropped dramatically. In addition, removing two person carpools from of the HOV lane and back into the general purpose travel lanes had a negative impact on the operation of the mixed flow travel lanes. In response to the low use of the Katy freeway lanes during the 3+ peak hour requirement, Houston has implemented a high occupancy toll (HOT) pilot program in the corridor. The purpose of the pilot program is to maximize the use of the HOV lanes and still maintain the travel benefit experienced by users of the facility. The HOT pilot program allows 2+ carpools to use the Katy Freeway HOV lane during the 3+ peak hour for a fee. It began in December of 1997. Prior to the implementation of the pilot program, 300 permits were sold with the option to expand the program as the facility is monitored to ensure adequate operations and speed. Tolls are collected automatically and cost two dollars per trip. Users will be charged when they pass a scanner that reads transponders placed on the dashboard of a vehicle. The scanners are located at access locations of the barrier separated HOV facility. Houston already has some toll facilities in the region and about 100,000 vehicles that are already equipped with transponders. Therefore, most of the basic infrastructure needed to implement the HOT lane is already in place.

As described above, the Seattle and Houston areas both have a strong commitment to HOV, but have taken very different approaches to the HOV systems they have developed. As this study proceeds, our region, with its unique characteristics and constraints, may also choose a distinct approach that addresses our particular needs.

4. Examples of HOV with the Bi-state Region

There have been two examples of HOV demonstrations within the Portland/Vancouver metropolitan region of significant scale over the last twenty years. The Banfield Freeway HOV, which began in 1976, was intended as a demonstration project. The I-5 trunnion repair project in September 1997 included HOV lanes on the I-5 and I-205 freeway corridors as a mitigation measure to the reduced capacity across the I-5 bridge.

Banfield Freeway HOV – The Banfield freeway is known as I-84 and is the east/west freeway connecting downtown Portland to Gresham and other points east of Portland. A portion of the Banfield opened as a demonstration of HOV in 1976 and began with a 3+ person carpool requirement. The HOV lanes ran westbound from 74th to 21st Avenue (3.2 miles) and eastbound from 44th to 74th Avenue (1.8 miles). The HOV lane was an addition to the existing general purpose travel lanes and was laid within the existing right of way by using the inside shoulder and narrowing the general purpose travel lanes.

During the 3+ stage the HOV lanes carried 210 to 300 vehicles per hour and 3,900 vehicles in the general purpose travel lanes. In 1979, because of the low number of vehicles in the HOV lane, the carpool requirement was changed to a minimum of two people per vehicle with the same peak period hours of operation. After the change to 2+ HOV, the number of vehicles HOV lane went up by more than three times to 1,000 HOV vehicles. Traffic in the general purpose travel lanes increased by 300 vehicles resulting in an increase in travel in the corridor. Average speed in the corridor also increased.

The Oregon Department of Transportation (ODOT) considered the Banfield HOV a success because more vehicles and people were moved through the corridor when the HOV lane was in place. They did identify some problems as well as factors important to the success of an HOV strategy. The short length of the HOV facility limited the potential benefit and utility to users. A longer segment would have provided greater travel time savings and possibly attracted more demand. Because of the limited right of way in this portion of I-84 the taper at the acceleration lanes was removed and caused some problems at the ramp merge locations. Enforcement was another important factor in the success of the lanes. Until 1981 the Oregon State Police who had a strong commitment to keeping the violation rate low were responsible for enforcement of the HOV lane. During the 1981 legislature, the traffic function of the Oregon State Police was pulled from the Portland area. Enforcement became the responsibility of the City of Portland and because of limited resources and competition from other critical police activities, enforcement of HOV lane violations became almost non-extistant. The average violation rate prior to 1981 ranged between 5% and 10%, after 1981 violations went up dramatically.

Other factors that contributed to the success of the Banfield HOV were: the existence of carpool parking incentives in downtown Portland, an eastside park and ride lot, and express transit service on the Banfield. The HOV segment was not intended to be permanent and was discontinued just prior to the reconstruction of the Banfield freeway and the eastside MAX light rail line. The high capacity transit mode in the I-84 corridor became LRT with the opening of the eastside MAX line in 1986. Average auto occupancy in the Banfield corridor (not including transit) was 1.28 to 1.32 during the demonstration compared to 1.2 on the other freeway corridors.

<u>HOV During the I-5 Trunnion Repair Project</u> – The northbound span of the Interstate Bridge was closed from September 16 to 21, 1997 by ODOT to replace the counterweight cables, drums, and trunnion on the north tower of the lift span. Prior to the closure, transportation agencies throughout the Portland/Vancouver region implemented a Transportation Management Plan to mitigate the impacts of reduced capacity across the Columbia River. The management plan strategies included HOV lanes in the I-5 and I-205 corridors, commuter rail service, carpool and vanpool programs, increased transit service and additional park and ride lots.

Although the short duration of the closure made conclusions difficult, the strategies contained in the plan were considered a success, due to the complete menu of alternatives offered to commuters. In the I-5 corridor, the non-SOV share of travel, excluding train passengers crossing the Columbia River, increased from 29% prior to the closure to 58% during the closure. In the I-205 corridor, the change was from 19% to 27%.

Analysis of HOV peak hour southbound river crossings indicate that there was a significant shift to non-SOV travel during the bridge closure. This is due in part to a significant decrease in automobile travel across the Columbia River. In addition, bus ridership increased in both the I-5 and I-205 corridors. Carpool use decreased in the I-5 corridor reflecting the overall reduction in auto demand especially in the I-5 corridor and the large shift in auto traffic to the I-205 corridor. At the same time, carpool/vanpool demand increased in the I-205 corridor by 30% even though drive alone auto demand in I-205 decreased.

Although the I-5 closure was too short a duration to make definite conclusions about a specific mode such as HOV, the I-5 HOV lanes carried 2,060 people during the morning peak hour. As a result of the performance of the strategies in place during the bridge closure, the ODOT is implementing an HOV lane pilot project in the I-5 corridor from the Going Street interchange to the Delta Park interchange. The pilot project will be in operation for nine months and will allow adequate time to conduct a comprehensive evaluation of the potential of HOV in the I-5 corridor.

5. Committee Experiences

This section provides a more qualitative assessment of HOV operations from around the country based on the experiences of Citizen Stakeholder Committee members. At their October 29 meeting, the Citizens Stakeholders Committee was presented with an overview of factors that support HOV strategies and have helped lead to successful HOV facilities. Those factors and their potential measures are described in detail in Section E of this chapter. Following the discussion of support factors, Committee members shared their experiences with HOV facilities which is summarized in Table 2-2. The Committee as a group has had extensive exposure to the use of HOV facilities around the country. This exercise was valuable because there was a high level of knowledge among Committee members about how well other HOV systems have worked from their perspective as users of the facilities. It helped staff to see what works and what doesn't and also enabled a comparison of how the factors identified by the experts mesh with the experience of Committee members.

Some common themes emerged from the Committee discussion. All the facilities that were identified by the Committee as having a high rating for bus or carpool volumes were identified as having high levels of congestion. In addition, for those who knew, the successful facilities also offered significant travel time savings and strong support programs such as commuter bus service and park and ride lots.

Table 2-2: Summary of HOV Facilities --- Committee Member Discussion

Area	Type of Facility	Congestion	Travel Time Savings	Existing Volumes			Support Programs *(Park and ride, commuter bus service)*	Employer HOV Incentives	Enforcement
				CP	*VP*	*Bus*			
Seattle, Washington	Barrier	+	+	+		0	+	+	+
Seattle, Washington	Inside	+	+	+		0	+	+	+
Seattle, Washington	Outside	+	+	-		-	+	+	+
Washington D.C region	Inside	+	+	0		0	X	X	X
Memphis, Tennessee	Outside	+	0	+		-	X	X	X
Atlanta, Georgia	Inside	+	+	+		+	+	X	X
San Diego, California	Barrier	+	+	0		0	X	X	X
Phoenix, Arizona	Inside	+	+	-		-	X	X	0
SF Bay Area	Inside	+	+	+		+	+	X	+
Southern California	Inside	+	+	0		0	X	X	X

+ : High rating; 0 : Moderate rating; - : Low rating; X: Not Known

E. Conditions That Support HOV Facilities

This section describes the conditions that support successful HOV facilities. These conditions are not firm rules, but are based on a review of the experiences of other regions throughout our country and what has been found to work. The consulting firm of Parsons, Brinckerhoff, Quade, and Douglas (PBQD) has conducted an extensive review of facilities nationwide and developed an HOV Guidelines Manual that includes a discussion of these factors. In addition, ODOT conducted a preliminary assessment of Portland metropolitan freeway corridors which included I-5 and I-205 to determine their HOV potential. These sources were used as a guide to develop locally defined conditions that could be used to assist in the development of criteria for assessing facilities in our region. The following table provides a brief comparison of the PBQD and ODOT factors with the locally defined factors described later in detail in this section.

Table 2-3: Comparison of HOV Support Conditions

ODOT Measures of Effectiveness	Parsons Brinckerhoff HOV Guidelines	Clark County Defined Factors
Existence of congestion	Congestion	Congestion
Travel time savings	Travel time savings	Travel time savings
Transit bus volumes	Vehicle throughput	Existing carpool/bus volumes
Existing HOV hourly volumes	Person throughput	Person mobility potential
Potential for impact to general purpose lanes	Cost effectiveness	Support programs
Financial feasibility	Physical characteristics	Enforcement
Geometric conditions	Enforceability	Public support
Access to HOV generators	Local agency/public support	Access between activity centers

The following section describes the conditions and factors that have been found to be supportive of successful HOV facilities. The PBQD and ODOT factors both contain specific parameters for assessing HOV potential. The measures for the Clark County defined factors described below were developed through a review of the parameters determined by ODOT & PBQD. The locally defined factors contain both quantitative and qualitative measures. These factors are intended to help provide a sense of the potential use of an HOV facility in a freeway corridor. They are the basis for the screening criteria for freeways described in chapter IV, section C.

1. Congestion

Unless a facility has congestion, there is little incentive for drivers to move to a shared ride mode. A high level of congestion in mixed traffic has potential to offer travel time savings for an HOV user. The congestion in a corridor should have the following characteristics:

- Level of service E during peak hour
- Level of service E in the next 5 years
- Peak hour average speed less than 30 m.p.h.

- Peak period average speed less than 35 m.p.h.

2. Travel time savings

This factor is directly tied to the congestion in a corridor but also accounts for the length of congestion along a corridor and the average distance a typical commuter travels along the corridor. The provision of an HOV lane in a corridor should be able to offer the following:

- One minute per mile time savings
- At least five minute savings
- Eight minute savings desirable
- For example, an increase in speed from 29 m.p.h. to 55 m.p.h. would offer one minute per mile travel time savings
- The greater the travel time savings, the better the benefit for HOV

3. Carpool and bus volumes

The level of existing carpool and bus volumes in a corridor can also provide an indicator of the potential for HOV; however, sometimes this data is not available. The carpool and bus volumes are used to show that there is enough existing carpool/bus demand to warrant providing HOV capacity. A corridor should generally have the following carpool/bus characteristics:

- 10% to 20% of the existing mixed flow traffic are carpools
- 800 HOV vehicles per hour is desirable or else lane may be perceived by the public as "empty"
- 300 to 400 HOV vehicles is absolute minimum
- 400 HOV vehicles is still low, but right on threshold

4. Person Mobility Potential

The person mobility potential of a corridor is to assess the ability of the HOV lane to carry more people than the adjacent general purpose travel lane. If enough people can be carried in the HOV lane, it can provide greater mobility and person capacity than general purpose traffic lanes. HOV person volumes:

- Should exceed person volumes in the adjacent mixed traffic lane
- Local definition for person volumes can be set lower
- Could initially be at least 20% of mixed traffic lane, should have potential to increase over time

The conversion of vehicles into people can provide an introduction to the person performance of the HOV lane and an idea of the vehicle mix that is needed to compete with the number of people carried by the typical general purpose travel lane.

The following table shows the possible mix of shared ride vehicles in an HOV lane:

Table 2-4: Example of HOV Lane Person Use

600 carpools @ 2 persons	1,200
10 vanpools @ 9 persons	90
15 buses at @ 50 persons	750
Total HOV Persons	2,040

5. Connection to activity centers

HOV facilities need to be located in corridors that have destinations where people want to go. The facility must connect high density origins and destinations. Ideally, they will provide direct access between activity centers such as park and ride facilities, employment centers, and other major activity centers. Park and ride facilities should be located adjacent to major transportation corridors and HOV facilities. In addition, HOV facilities should have direct access to major employment centers such as downtown Portland or other regional employment or shopping centers. High employment and shopping locations are needed in order to generate the trip activity in the corridor to these destinations to justify HOV utilization. If centers are located too far from an HOV facility, the benefit of using the facility is diminished.

6. HOV Support Programs

A critical element of a successful HOV facility includes the existence of HOV support programs. These programs all help support an HOV facility and provide a strong foundation for a successful system. They work together to strengthen rideshare activities in the community. When combined with a facility that has high congestion and potential travel time savings as well as other conditions that favor HOV, support programs can provide a critical link in their success. Support programs consist of:

- Rideshare programs
- Vanpool programs
- Carpool programs
- Ride matching services
- Employer trip reduction programs
- Express transit service

Vanpools can be employer or public agency based. The Washington State Commute Trip Reduction Law, which affects 51 employers in Clark County, is a good example of a state mandated employer trip reduction program.

7. Enforcement

Another important component of a strong HOV program is enforcement. Enforcement is important to ensure safety in using the HOV facility. It is also important to maintain the sense of equity and fairness perceived by the public. If the facility is not adequately enforced, the resulting high violation rate could lead to public resentment and a deterioration in the operation and effectiveness of the facility. Any consideration of implementing an HOV facility should ensure that:

- There are the resources and commitment for effective enforcement
- The design includes consideration of enforcement
- There is early involvement of enforcement agencies
- There is a commitment by agencies to do enforcement

8. Local and Public Support

The success of an HOV facility is dependent on many factors. Numerous agencies are responsible for coordinating their efforts in the operation of an HOV facility and the support services. For example, HOV lanes are typically on state facilities, express transit service is provided by the local transit district, local roads are used to access HOV facilities, and local rideshare programs may be the responsibility of the local transportation agency or private employers. Local, regional, and state agencies must work together in a multi-jurisdictional effort to include HOV as an element of a coordinated strategy for providing travel options.

In addition to governmental agencies, local support from the general public is also important. The purpose of any participation and awareness programs is not just to gain support for the HOV facility. It is also to increase public understanding on the location and use of the facilities and knowledge of travel options for bus service, park and ride lots, vanpool programs and so on. These activities should be geared toward not only the general public but also to the business community whose employees could be affected by HOV strategies. Some of the key strategies for public support include:

- Active education and marketing programs
- Public participation and awareness programs prior to any HOV implementation
- Getting feedback and consensus from public on proposals
- Education and marketing as an ongoing process to maintain broad based constituency for HOV during and after implementation

CHAPTER III.
HIGH OCCUPANCY VEHICLE GOALS AND POLICIES

A. BACKGROUND

The goals and policies described in this chapter are the foundation for the development of the HOV alternatives described in chapter IV. They are intended to meet our region's unique needs and to define the role of HOV in the Clark County region. They are also consistent with the adopted policies of the Washington State Department of Transportation (WSDOT). The regional HOV goals for Clark County provide the vision of what an HOV system for our region should accomplish. The proposed policies define the purpose of the HOV system and provide the framework for defining the operation of HOV facilities in our region. The regional HOV system goals and policies will be incorporated into the HOV Study and finally into the Metropolitan Transportation Plan. They will guide the regional decision-making process for the development of a regional HOV system in Clark County. These policies have been reviewed by the Citizen Stakeholders Committee, The Regional Transportation Advisory Committee (RTAC), and the RTC Board of Directors. They also reflect additional discussions with WSDOT staff to ensure consistency with state policy. Section B describes the State System Policies on HOV. Section C contains the Clark County regional goals and policies.

B. STATE POLICIES

WSDOT has policies in place for freeway HOV facilities and recognizes that each region needs to address congestion with a variety of solutions. State policies support a collaborative process between the Metropolitan Planning Organization (MPO) and the WSDOT to define the role HOV facilities should have on the regional transportation system and how they would work as a congestion management strategy for the region. The state's primary interest is to ensure that the design and operation of the facilities meet safety standards, driver expectations and that facilities are developed and operated according to an adopted set of HOV system policies. The HOV system objectives and policies apply only to freeways and do not apply to other state facilities.

The state HOV system policies are to:

- Improve mobility by increasing the people moving efficiency and capacity of freeways.
- Provide reliable travel time savings for people who choose higher occupancy vehicle modes of travel.
- Improve efficiency and safety of both transit and highways.

In addition, regions must have adopted HOV policies in place to compete for statewide funds in the engineering, design or construction of HOV facilities. While the state assumes responsibility to seek funding for the construction of HOV facilities, it considers HOV system support facilities such as park and ride lots and transfer facilities a shared responsibility.

C. REGIONAL GOALS AND POLICIES

1. Clark County Regional System Goals

The regional HOV system goals described below are consistent with state policies and address our region's unique needs for freeway and arterial HOV facilities. Overall, it is the region's policy to implement HOV facilities in the most congested corridors that will benefit transit and carpool users by providing reliable travel time savings for shared vehicles to bypass single occupant vehicle congestion.

The proposed goals for a regional HOV system in Clark County include the following:

- Improve mobility for persons and freight.
- Emphasize person-carrying capacity of major transportation corridors over vehicle-carrying capacity.
- Give priority to shared ride commute trips occurring during the peak period.
- Support transit service and transit reliability in arterial corridors as well as carpool/vanpool use.
- Manage congestion by improving efficiency and use of transportation corridors.
- Ensure bi-state coordination on HOV system and operations for interstate facilities.

The proposed regional HOV policies for Clark County separately address freeways and arterials due to the different operational characteristics between a freeway and an arterial HOV facility.

2. Freeways

These HOV policies are intended to define the purpose of HOV facilities in our region and their role as a transportation strategy. A framework for HOV operating policies is also described and addresses issues such as enforcement and hours of operation.

HOV Policies:

- Provide for the management of freeway transportation corridors through the development of HOV facilities that address recurring congestion, traffic bottlenecks, and incident management.
- Implement HOV lane facilities in transportation corridors where congestion levels are high and where travel time savings for bus or carpool persons are significant.
- HOV support programs and facilities, such as carpool/vanpool programs, express bus service, and park and ride facilities, shall be in place or planned for any transportation corridor being considered for HOV use.
- Implementation of HOV lanes in the freeway corridors shall be complemented and/or preceded by congestion management strategies such as ITS and incident management, and ramp metering to maximize transportation system efficiencies.
- HOV support facilities and programs will also be in place prior to HOV lane implementation.
- The long range goal for the implementation of freeway HOV facilities is through added capacity to accommodate HOV.
- The conversion of general purpose travel lanes for HOV use will be considered as a "phased" approach to implementing a long range HOV system plan or other non-SOV capacity improvement strategy in the corridor.
- Freeway facilities with proposed or planned capacity improvements for traffic shall be assessed for their potential HOV use.
- Provide for the long-term management of HOV lane demand by maintaining the option for future conversion to high occupancy toll usage.
- Spot treatments (such as ramp bypass) will be considered to provide priority access for shared ride users and to supplement HOV lane facilities.

3. Freeway Operating Policies

Framework for HOV Operating Policies: before implementation, HOV operating policies must be adopted jointly by the WSDOT, RTC, C-TRAN, local governments, the Washington State Patrol, general freeway users and the freight and environmental community. Operating policies for HOV will:

- Support HOV system objectives.
- Include a speed and reliability standard to ensure that HOV facilities will continue to provide a reliable travel time advantage compared to congested general purpose travel lanes and a process to enforce to that standard.

- Maintain consistency with adopted state policy regarding occupancy requirements, hours of operation, inside versus outside lane operation, and enforcement.
- Provide for public review and comment on HOV proposals or changes.
- Be consistent with WSDOT statewide design and operation standards for HOV facilities.

Specific operating policies will need to go through an adoption process by HOV stakeholders as described above. The freeway HOV operations for the Clark county System Plan are defined in chapter VI, section B.4. They will form the basis for a more comprehensive development of operating policies for a Clark County HOV system.

4. Arterial HOV System Policies

Arterial HOV policies are not required in order to be consistent with WSDOT's HOV policies. However, to plan for an entire HOV system concept, they are an important part of our HOV study.

- The primary purpose of arterial HOV facilities is to promote bus movement and transit reliability, and in addition, provide a time-savings benefit for carpool/vanpool users.
- The traffic management policy for arterial HOV will establish priority for transit travel by giving preferential treatment to buses, carpools, and vanpools along the arterial as well as where the arterial intersects with freeway HOV facilities.
- Arterial HOV will provide improved access to a freeway HOV facility and complement the freeway HOV system. It will provide transit priority at locations along a corridor where there are significant congestion points, bottlenecks, and failing intersections.

CHAPTER IV.
DEVELOPMENT OF HOV ALTERNATIVES

This chapter describes the process leading to the development of the HOV alternatives that are evaluated in chapter V. Section A describes background information about travel and growth within Clark County and between the county and the Portland metropolitan area. Section B describes the transportation corridors that went through an initial screening process to determine their potential for HOV. Section C contains the criteria for conducting the screening process for the candidate corridors. The evaluation of the candidate corridors and their potential for HOV are described in section D. HOV alternatives developed for detailed evaluation are described in section E.

A. BACKGROUND TRAVEL INFORMATION

The Citizen Stakeholders Committee was presented with extensive information about travel patterns, transportation related growth, and transportation system performance. This section summarizes travel data that was presented to the Committee during the course of the study. Since that time, new information has become available including new growth projections and additional traffic counts that are not included in this section.

1. Travel Patterns

a) Population and Employment

The high growth in Clark County has been a major issue over the last several years. Between 1990 and 1996 the population of the county has increased by 27% from 238,100 to 303,500 people in 1996. The growth rate is expected to slow over the next six years with a 17% increase in population to 355,000 between 1996 and 2003. This high growth rate has continued with a population estimated at 328,000 in 1998.

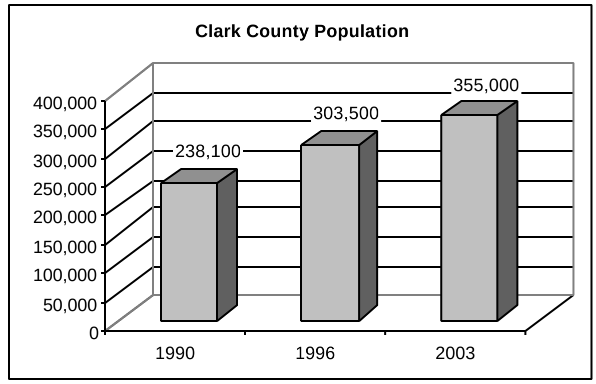


Figure 4-1: Population Growth

The employment trend in Clark County during the same time period is similar, but with somewhat different rates of growth. Between 1990 and 1996, Clark County employment increased at a slower rate than population growth (24% to 27%). From 1996 to 2003, employment is projected to grow at a faster rate than population during the same time period and will increase by 20% to 159,800 compared to a 17% growth in population.

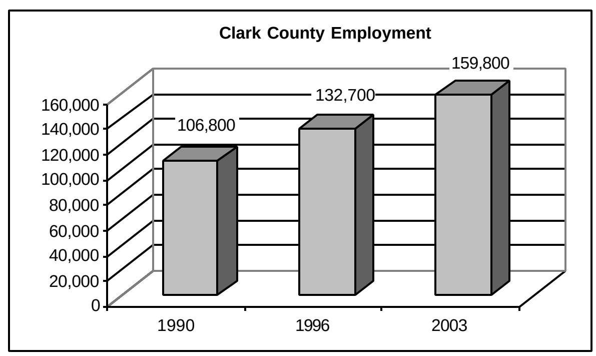


Figure 4-2: Employment Growth

b) Major Destinations

Figure 4-3 displays the amount of daily travel by people living in Clark County to five major destinations in the Vancouver/Portland metropolitan area. As described in the previous chapter, one of the factors in the success of HOV facilities are the connections

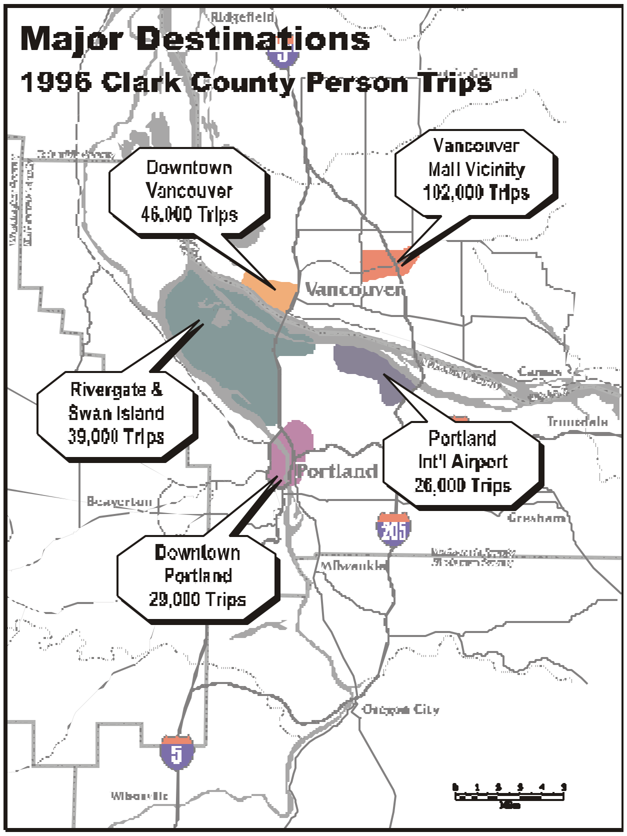


Figure 4-3: Major Destination for Clark County Residents

they provide between activity centers. Travel to the destinations is for all trip purposes. Although Vancouver Mall attracts the highest number of trips from Clark County, a significant number of them are shopping trips going to retail destinations. By contrast, travel to downtown Portland and the Rivergate/Swan Island area is comprised primarily of work trips. Generally, the HOV market is made up of travel to and from employment centers.

c) Traffic Growth

Table 4-1 shows historical traffic growth between 1985 and 1996 for the four highest volume intersections in Clark County. As population and employment has grown in Clark County, the growth in vehicle travel has grown at a faster rate than the population. Between 1990 and 1996, all four intersections had a higher annual growth rate than the 4.5% annual growth rate for Clark County. The intersection of Mill Plain Boulevard and Chaklov had the highest growth rate at 10.6% per year. Between 1985 and 1996 traffic volumes have more than doubled at three of the four intersections. The highest overall growth in traffic has occurred at SR-500 and Thurston Way, which has increased by 130% since 1985.

Table 4-1: Highest Volume Intersections in 1996

Year	Average Weekday Traffic	Annual Traffic Growth Rate
1985	40,300	
1990	56,200	7.9%
1996	81,000	7.4%

SR-500 and Gher Road

Year	Average Weekday Traffic	Annual Traffic Growth Rate
1985	32,000	
1990	49,000	10.6%
1996	76,000	9.2%

SR-500 and Thurston Way

Year	Average Weekday Traffic	Annual Traffic Growth Rate
1985	42,600	
1990	46,700	1.9%
1996	76,000	10.6%

Mill Plain Boulevard and Chaklov Drive

Year	Average Weekday Traffic	Annual Traffic Growth Rate
1985	31,900	
1990	44,200	7.7%
1996	66,000	8.2%

SR-500 and SR-503

d) Columbia River Crossings

A good indicator of change to bi-state travel is the amount of vehicle travel across the Columbia River bridges. Table 4-2 and Figure 4-4 shows the historical growth in Columbia River bridge crossings since 1980. In 1980, the only highway across the Columbia River was the Interstate Bridge which carried 108,600 vehicles a day. By 1985, with the opening of the Glenn Jackson Bridge in 1983, Interstate Bridge volumes decreased to 91,400 vehicles a day. However, the new I-205 bridge carried 52,600 day for a combined river crossing of 144,000 vehicles a day. By 1996, total river crossings (231,900) had more than doubled compared to 1980 (108,600). On the I-205 bridge, vehicle volumes have also more than doubled between 1985 and 1996. While traffic on both bridges has continued to grow since 1990, the Interstate Bridge is at capacity about six hours a day. As a result, future growth is expected to be more constrained than on the Glenn Jackson Bridge.

Table 4-2: Average Weekday Traffic Across the Columbia River

Year	I-5	I-205	Total
1980	108,600	n/a	108,600
1985	91,400	52,600	144,000
1990	95,400	87,100	182,500
1996	118,600	113,300	231,900

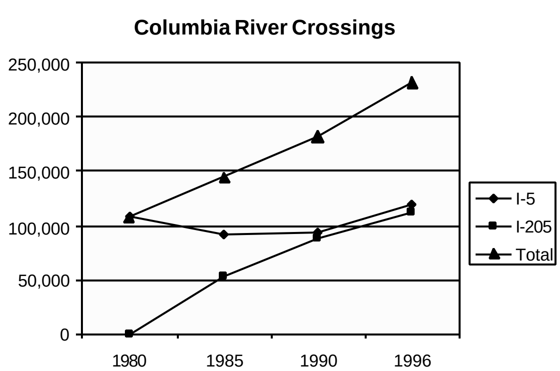


Figure 4-4: Columbia River Crossings

2. System performance

a) Average Trip Length

The measure of average trip length provides some guidance on whether the trip distances by Clark County drivers are long enough to offer enough travel time savings to potential users of an HOV system. The longer the trip length the greater travel time savings in a congested transportation corridor. The table below shows average trip length for people staying within Clark County and those that cross the Columbia River. “All Trips” are for all purposes and include travel to work, shopping, school, recreation and other purposes. “Work Trips” only count commuting to and from the work place. The trip length for all trips is shorter because destinations and opportunities for shopping, school, and so on are closer to home. As indicated by the table, bi-state travel between Clark County and Oregon have the longest trip distances. Based on trip length, the bi-state travel market may provide the best opportunity for HOV use.

Table 4-3: Average Trip Length

Destination	All Trips	Work Trips
Internal Clark County	4 miles	6.3 miles
Clark County to Oregon	12.9 miles	15.1 miles

b) Volume to Capacity Ratios

1996 p.m. peak hour capacity deficiencies are located along the I-5 corridor, the eastern end of SR-500 in the vicinity of I-205 and in the Mill Plain Boulevard/I-205 area. By 2003, capacity deficiencies at the locations previously mentioned are more severe and a number of new deficiencies occur. 2003 capacity needs are located at: SR-14 from I-205 to 164th Avenue, SR-503, portions of 164th Avenue, Burton

Road/18th Street, and additional locations around the county.

c) Vehicle Hours of Delay

Vehicle hours of delay is the measure of the additional delay experienced by vehicles travelling on a facility when the average speed falls below normal uncongested driving speeds. For example, a single car traveling at 55 miles per hour on I-5 from SR-14 to I-205 would take about 7.5 minutes and have no delay. At 25 miles per hour, the trip would take almost 17 minutes and the vehicle will experience 9.5 minutes of delay. Vehicle hours of delay measures the total combined delay experienced by all the vehicles travelling along a defined segment of a facility. Figure 4-3 displays p.m. peak hour vehicle hours of delay on the major transportation corridors in Clark County. It also shows peak hour travel speeds at the Columbia River bridge crossings.

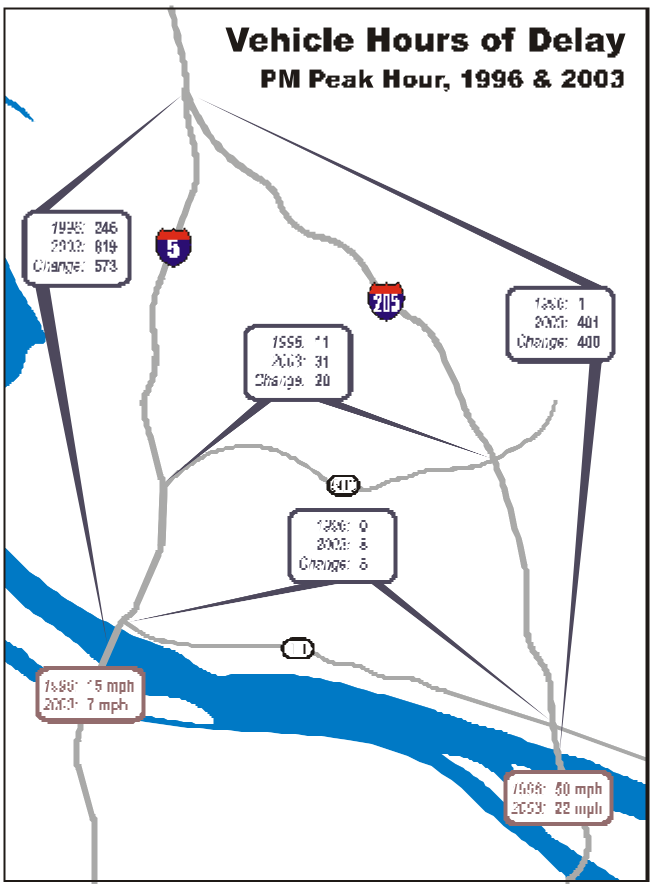


Figure 4-5: PM Peak Vehicle Hours of Delay: 1996 and 2003

The I-5 corridor experiences the most delay in 1996 and increases by more than three times to 819 hours by 2003. In 1996, the I-205 corridor had a very small amount of total delay, but by 2003 had increased to 401 hours. The delay on SR-14 also goes up, but is only at 8 hours by 2003. Speeds on both bridges are expected to deteriorate significantly by 2003, although the Interstate Bridge has the slowest speed in 1996 and 2003 at 15 and 7 miles per hour, respectively.

B. Candidate Transportation Corridors

This section of chapter IV describes the candidate transportation corridors for freeway and arterial facilities, shown on Figure 4-6, that advanced through a screening process and resulted in the selection of smaller facilities for the development of HOV alternatives. These candidate corridors represent the full set of transportation corridors considered as potential HOV facilities. The candidate corridors were presented to the Citizen Stakeholders Committee, RTAC, and the RTC Board of Directors and were modified based on their comments. They comprise the initial set of transportation corridors that will be assessed for their HOV potential. The screening of the candidate corridors was conducted by using criteria contained in section C of this Chapter.

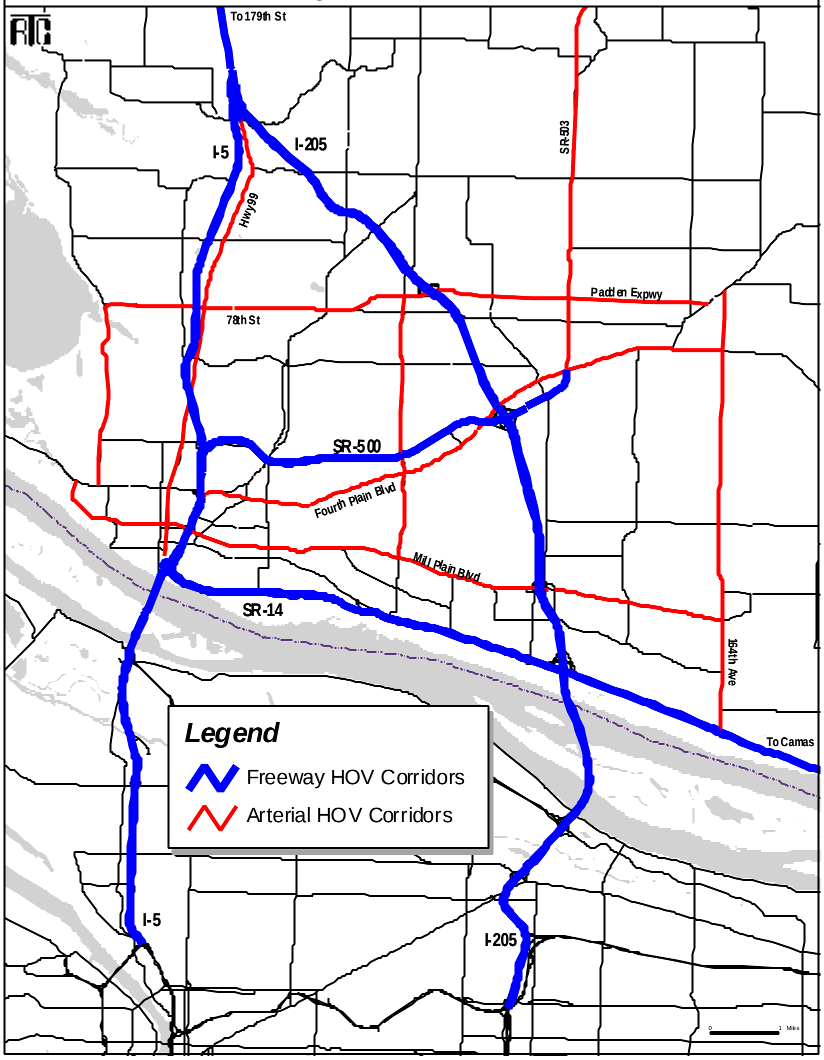
1. Freeways

Freeway facilities were defined as limited access interstate and state roadways that have regional and bi-state traffic. They are facilities with the potential to serve the longer distance carpool, transit and vanpool trips. Initial evaluation of freeway corridors occurred using the screening criteria described in the following section and determined the transportation facilities for which HOV alternatives were developed and that underwent detailed evaluation.

- I-5 (I-405 in Oregon to 179th Street)

- I-205 (I-84 in Oregon to 134th Street)
- SR-14 (I-5 to Camas)

Candidate HOV Freeway and Arterial Corridors



- SR-500 (I-5 to SR-503)

Figure 4-6: Candidate Freeway and Arterial Corridors

2. Arterials

Arterial facilities were determined using a more qualitative process but are comprised primarily of principal arterials that are not limited access facilities. They are generally in the urban area, connect important activity centers, carry intra-urban traffic, and have existing or planned bus routes.

- 78th/Padden (Fruit Valley Rd to Ward Rd)
- Hwy 99/Main St (7th St to 134th St)
- Fourth Plain Blvd (I-5 to 164th Ave)
  - SR-503 (Fourth Plain to 219th St)
  - Mill Plain Blvd (Fourth Plain to 164th Ave)
  - 164th Avenue (SR-14 to Ward Rd)
    - Fruit Valley Rd (Fourth Plain Blvd to 78th St)
    - Andresen Rd (Mill Plain to Padden Parkway)

C. Criteria for Screening Candidate Corridors

1. Purpose and Use

The screening criteria described in this section were used to evaluate the candidate corridors from the previous section and identify corridors for the development of detailed alternatives. The Citizen Stakeholders Committee, RTAC and the RTC Board reviewed the evaluation criteria for freeways. The freeway criteria consist of a combination of qualitative and quantitative measures and were developed based on a review of HOV literature, summarizing the experiences of regions around the country, and of conditions that have led to successful HOV facilities which are summarized in chapter II, section E. The corridors were evaluated based on the adopted MTP 2017 travel forecast which does not include any HOV facilities.

The evaluation of arterial facilities underwent a more qualitative process. The operational characteristics for HOV treatments on arterial facilities differ significantly from freeway facilities in that their purpose is primarily to promote bus movement and secondarily to provide a benefit for carpool users. In addition, there is a wide range of HOV types that can be used on an arterial facility.

2. Freeways

The regional evaluation criteria for freeways are based on the locally defined factors described in chapter II, section E. Some of the conditions described in that section, such as enforcement and public support, are not included in the evaluation criteria. They do not need to be addressed until later in the planning process prior to the implementation of a facility. Table 4-4 is a matrix of the regional criteria that was used to evaluate, screen and rank the freeway corridors.

3. Arterials

a) Process for Screening Arterials

Arterial HOV facilities, unlike freeway HOV facilities, will not generally encourage a shift to other travel modes. Arterial HOV cannot offer the same degree of travel time savings as freeway HOV due to the shorter trip lengths and more dispersed travel patterns on arterials compared to freeways.

Arterial policies discussed in chapter III, section C.4. provide the main guidance on the consideration of arterial HOV facilities. The policies state that arterial HOV facilities be considered as a "traffic management policy that gives preferential treatment to buses" but also "provides support for HOV vehicles at their point of intersection with the HOV freeway system." The arterial HOV policies provide the framework for which facilities are identified for potential HOV treatment. They are intended to emphasize the promotion of bus movement and transit reliability and to improve HOV connections between the arterial system and the freeway HOV system.

Arterial HOV corridors underwent a different evaluation process than the freeway corridors. Detailed performance measures were not developed for the candidate HOV arterial corridors. Arterial segments and locations were determined by examining travel data and transit bus demand in the corridor and at individual intersections. This process is described in section D.2. of this chapter and resulted in the identification of HOV arterial lane segments and locations proposed for HOV treatment. Except for information needed to identify arterial facilities, no further analysis is planned at this time.

There is a wide-range of HOV spot treatments that can be applied at arterial intersections and other locations. Arterial HOV facilities will be included in the HOV system plan with the recognition that detailed operational analysis will need to be conducted to determine the most effective arterial HOV treatment for each location. The detailed analysis would determine the type and amount of signal priority for bus movement and the impact on the operation of non-HOV traffic using the intersection. It will include balancing mixed flow traffic needs with the traffic management objectives to establish priority for transit person travel. That level of analysis will not be done for this study, but will need to be conducted prior to implementation of any arterial HOV treatments.

D. EVALUATION OF CANDIDATE CORRIDORS

1. Freeways

The evaluation of the candidate freeway corridors used 2017 travel forecast data from the adopted MTP. It does not assume HOV in any of the corridors. For the purposes of this analysis, there is no LRT to Vancouver. The travel data was based on the criteria described in the previous section and is used for this evaluation. Part b) contains a matrix summarizing how the travel data compares with the evaluation criteria. Part c) ranks the freeway corridors based on the evaluation.

a) Travel Data

Congestion - The map on Figure 4-7 displays 2017 p.m. peak hour congestion levels on the freeway corridors. The I-5 corridor is expected to be the most congested of the four freeway facilities evaluated for HOV potential. It is forecast to operate at level of service (LOS) E to F for most of the length of the corridor from the Fremont Bridge in Portland to 99th Street in Vancouver. I-205 will also experience high levels of congestion (LOS E or F), especially in the segment from I-84 in Portland to Mill Plain Blvd. in Vancouver.

Table 4-4: Criteria for Screening Candidate Freeway Corridors

Regional Criteria		Measure	Description
Forecast congestion	—	LOS D or better	Level of service (LOS) is based on forecast conditions. It indicates the degree of congestion on a transportation facility. LOS A represents the best operation and LOS F indicates the poorest operation.
	0	LOS E or worse	
	+	LOS F	
Travel time savings	—	Less than 5 minutes	Amount of travel time savings in the High Occupancy Vehicle (HOV) lane compared to travel time in the adjacent general purpose lane.
	0	5 to 8 minutes	
	+	More than 8 minutes	
Person mobility potential	—	Persons < 20% of mixed traffic	HOV eligible vehicles are converted to people to calculate baseline person use of HOV facility compared adjacent general purpose (GP) lane.
	0	Persons 20% to 50% of mixed traffic	
	+	Persons > 50% of mixed traffic	
Impact on general purpose travel lanes	—	One GP lane	Assumes that HOV will add a lane. This is a qualitative measure that assumes merging and weaving impacts between HOV and GP will be reduced with more GP lanes available.
	0	Two GP lanes	
	+	Three+ GP lanes	
Access between activity centers	—	No access between activity centers	Indicates how well the HOV facility connects activity centers. Neutral value would indicate an arterial connection between the HOV facility and an activity center. A positive value indicates a direct connection.
	0	Indirect access	
	+	Direct access	
Consistent with city/county land use plans	—	Not identified as multi-modal corridor	The transportation elements of the city/county comprehensive plans support transportation options and alternatives. They also call for multi-modal alternatives in specific transportation corridors.
	0	Only portion of corridor is multi-modal	
	+	Entire corridor is multi-modal	

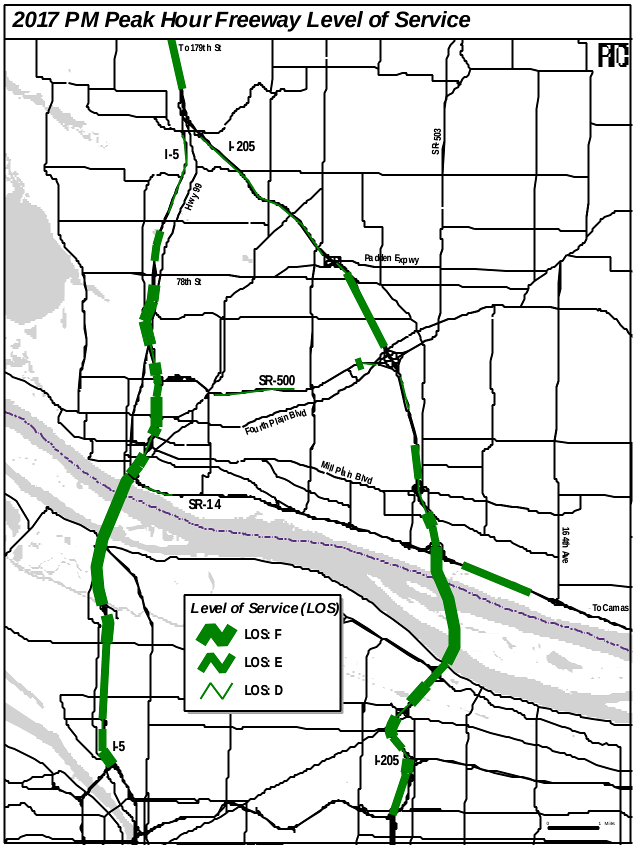


Figure 4-7: 2017 PM Peak Hour Freeway Level of Service

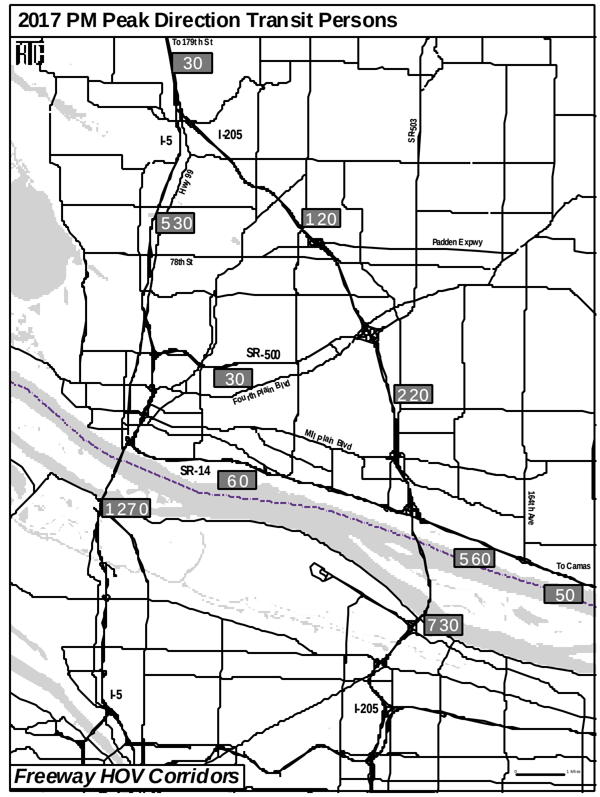


Figure 4-8: 2017 PM Peak Direction Transit Persons

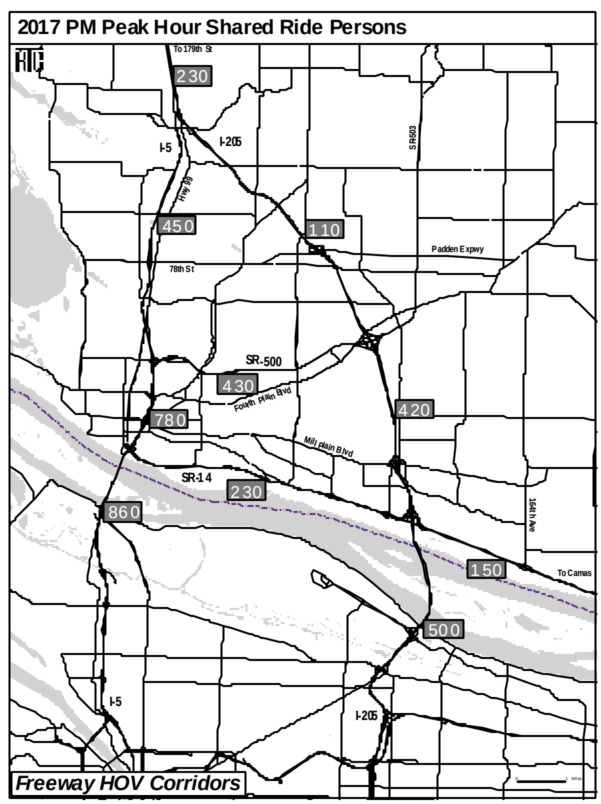


Figure 4-9: 2017 PM Peak Direction Shared Ride Persons

Person Mobility Potential – The forecast of transit and carpool persons is intended to assess the person mobility potential of the freeway HOV corridors. Figures 4-8 and 4-9 display the p.m. peak hour transit and carpool persons estimated for each HOV corridor in 2017. The forecast is based on the MTP highway and transit system and does not include additional shared ride persons resulting from the provision of HOV. I-5 and I-205 have the highest corridor volumes of people that represent the likely HOV market. I-5, however, has the highest person volumes of the two corridors with a total of 2,130 transit and carpool persons just south of the interstate bridge. SR-14 also has a significant number of transit persons east of I-205, due to the transit service planned park and ride lot at Fisher's Landing. The southern portions of the I-5 and I-205 corridors have the highest transit and carpool use.

Travel Time Savings – This measure compares the 2017 travel time in the general purpose travel lanes of the candidate corridors with travel time in an HOV lane when the HOV lane is assumed to operate at a speed of 50 mph. Figure 4-10 shows the average p.m. peak hour speeds in the general purpose lanes and the HOV travel time savings by segment and for the full length of the corridor. HOV lanes in the I-5 corridor offer the most potential travel time savings of the four freeway corridors with a total corridor savings of more than 28 minutes. I-205 also has significant travel time savings with an HOV lane providing almost 12 minutes faster travel time than the general purpose travel lanes. There is minimal travel time savings in the SR-500 and SR-14 corridors. Two thirds of the SR-14 travel time savings occur on the segment between I-205 and 164th Avenue.

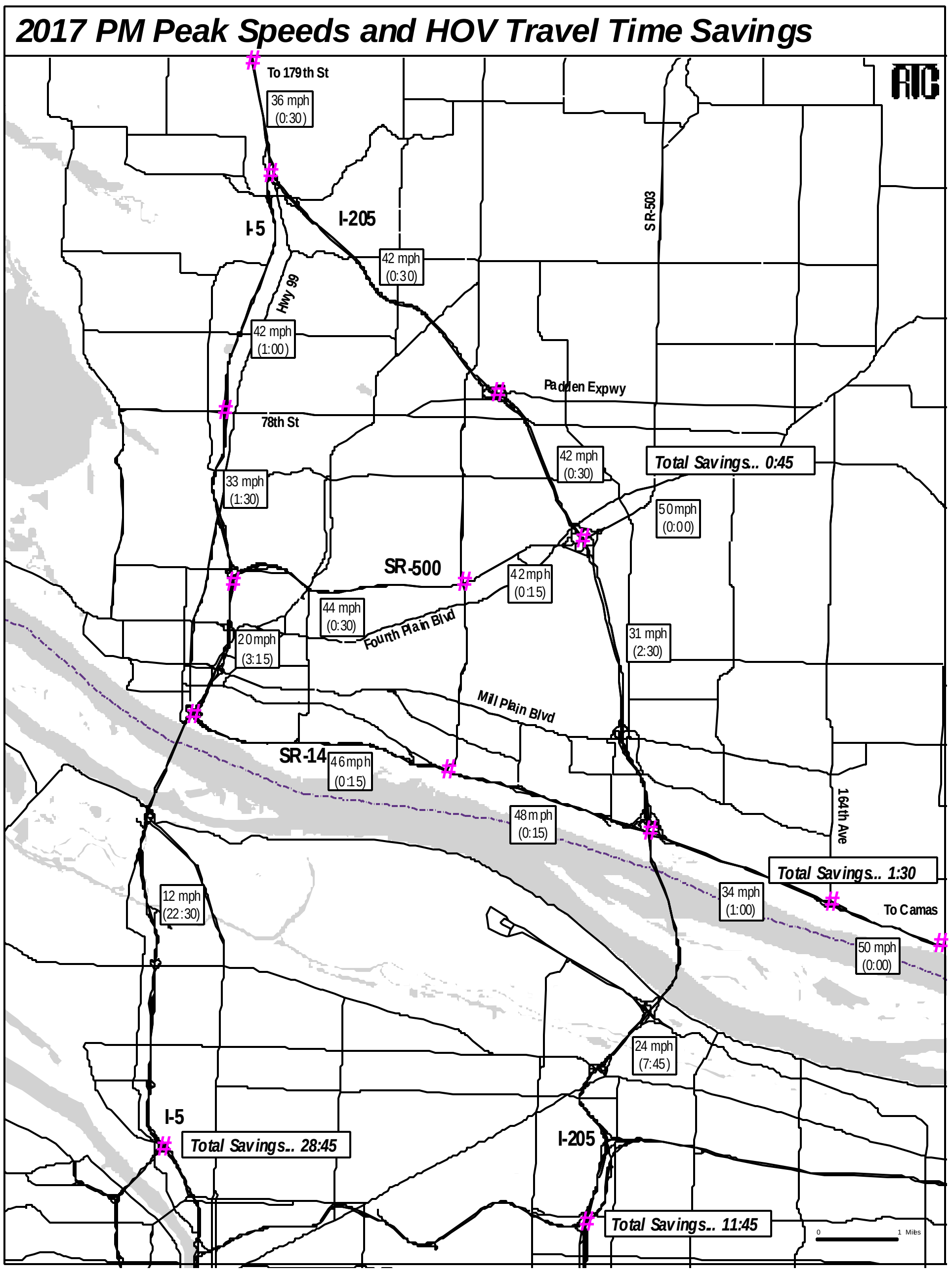


Figure 4-10: 2017 PM Peak Speeds and Travel Time Savings

General Purpose Travel Lanes – Figure 4-11 shows 2017 general purpose travel lanes for each of the freeway corridors. The number of travel lanes shown represent only through lanes and do not include auxiliary lanes such as those used to access and exit the freeway. The I-5 corridor, except for the Delta Park vicinity, has at least three travel lanes in each direction. I-205 has at least three travel lanes from Gateway to SR-500 with four lanes each way across the Columbia River. All of SR-14 and most of SR-500 consists of two travel lanes. HOV lanes operated more safely in corridors where there is a greater number of general purpose travel lanes.

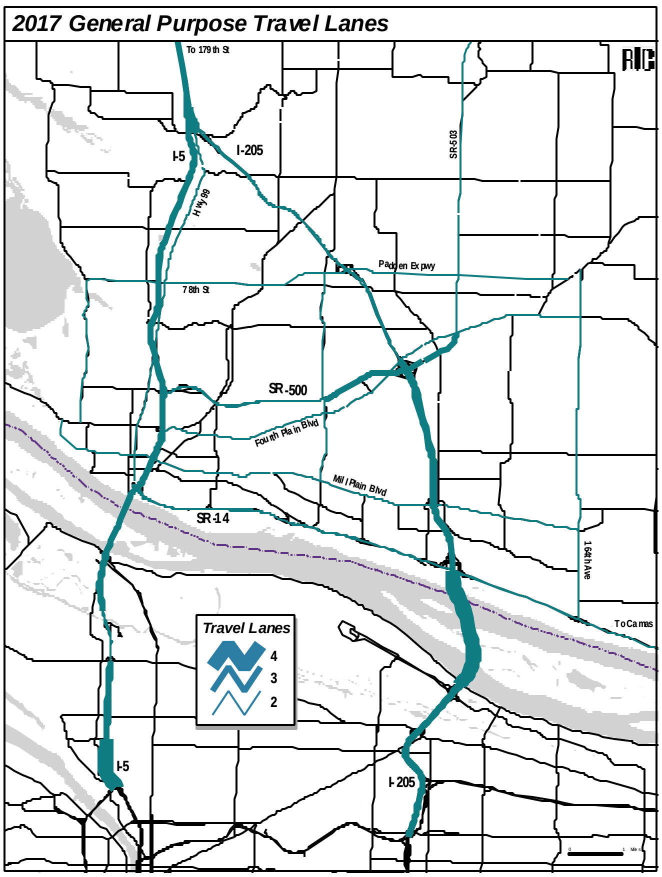


Figure 4-11: 2017 General Purpose Travel Lanes

Access Between Activity Centers – Figure 4-12 is a map of the major activity centers for Clark County drivers. The locations of existing and planned Clark County park and ride lots and the top three destination areas in Clark County consist of Salmon Creek, downtown Vancouver, and Vancouver Mall. The Fisher's Landing area is also an important destination area with major employers such Hewlett-Packard, LDI Inc, and Wafertech. Other locations of note are the Southwest Washington Medical Center, and Columbia Shores.

The I-5 corridor has fewer destination areas than other corridors, but it does provide a direct connection between three critical activity centers: Salmon Creek, downtown Vancouver, and downtown Portland. Salmon Creek park and ride activity center is adjacent to the I-5 and I-205 corridors. The planned park and ride lot at 99th Street is also adjacent to I-5. There are two activity centers located within the I-205 corridor with direct access to the freeway: Vancouver Mall and Cascade Park. The planned park and ride lot on Padden Parkway will also have easy access to I-205.

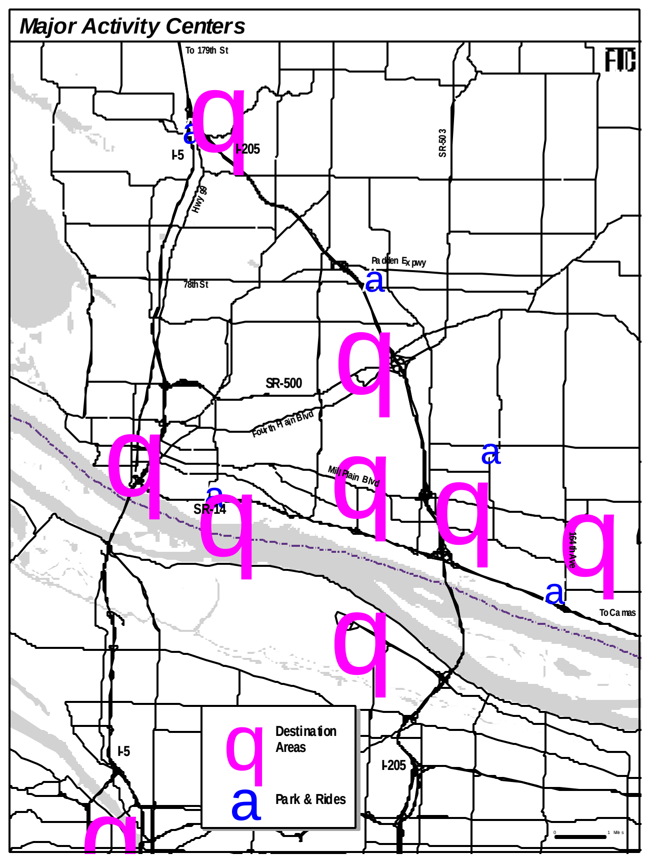


Figure 4-12: Major Activity Centers

Consistent with City/County Land Use Plans – The currently adopted Metropolitan

Transportation Plan includes the regional transportation system and defines the planned transportation function and use of the regional transportation facilities. All four of the candidate HOV corridors have existing or planned bus service. In addition, I-5, I-205, and SR-500 are defined as multi-modal corridors and have been given a high capacity transit designation. Their multimodal use has not yet been determined but will be identified in future MTP updates. This HOV study, for example, will determine what role HOV will play in the designated HCT corridors.

b) Comparison to Criteria

Table 4-5: Candidate Freeway Evaluation Results

Regional Evaluation Criteria	Corridors			
	I-5	I-205	SR-14	SR-500
Existence of congestion	+	+	0	0
Travel time savings	+	+	-	-
Person mobility potential	+	0	0	-
Impact on general purpose travel lanes	+	+	0	0
Access between activity centers	+	+	+	+
Consistent with city/county land use plans	+	+	0	+

- = Does not meet criteria
0 = meets criteria
+ = exceeds criteria

This section uses the analysis as presented in the previous section. The travel data on congestion levels, travel time savings, person mobility potential, impacts on general purpose travel lanes, access between activity centers, and consistency with comprehensive plans was reviewed and was used to develop the evaluation results shown in Table 4-5. The results displayed in the table are based on how well the transportation characteristics of the candidate corridors met the evaluation criteria described in section C.2.

c) Ranking

This section provides an overall ranking of the corridors and is the last step in the process, prior to the identification of corridors and the development of alternatives for detailed study. The purpose of the ranking process was to provide an overall rating of the freeway corridors based on the evaluation from the previous section. That process provided an assessment of the corridors for each individual criterion. The ranking of freeway corridors combines the criteria into a single measure to show the relative performance of the corridors to each other. The ranking of corridors was established by assigning point values to the symbols used in the evaluation matrix. The point system was assigned as follows:

+ = 2 points
0 = 1 points
- = 0 points

The following ranking of corridors resulted using the point system above.

- I-5 = 12 points
- I-205 = 11 points
- SR-500 = 6 points
- SR-14 = 6 points

The ranking of the corridors only affected the level of HOV treatment that was considered during the development of alternatives. A low corridor ranking did not necessarily mean that there would be no consideration of HOV, but may affect the type and level of HOV treatment that may be appropriate for that corridor. For example, if a corridor has little congestion or has no travel time savings with the implementation of HOV, a ramp bypass treatment could offer priority access to the facility for transit and shared ride persons.

2. Arterials

a) Travel Data

This section summarizes the travel data developed for the candidate arterial corridors and used 2017 travel forecast for the adopted MTP. The arterial corridors were described earlier in section B.2. of this chapter and displayed in Figure 4-6. The travel data developed for the arterial corridors include information on p.m. peak congestion levels along the corridors, the p.m. peak hour service of the major intersections of the corridor, and the transit person demand.

Corridor Congestion –A significant number of the arterial corridors are forecast to experience severe congestion in 2017. The corridor level of service map shown on Figure 4-13 indicates that Mill Plain Blvd. in the vicinity of I-205, will operate at LOS E to F. Andresen Road is also expected to operate between LOS E to F for many portions of the facility from Mill Plain Blvd. to 63rd Street. The 164th corridor has a few short segments operating at LOS E or F where Padden Parkway has two segments operating at LOS E.

Other corridors with high levels of congestion along significant portions of their length include SR-503, Main Street/Hwy 99, and Fruit Valley Road.

Intersection Level of Service – An intersection level of analysis for the arterial corridors is shown in Figure 4-14. The map shows locations along the corridors where the 2017 forecast indicates the intersections will operate at LOS E and F during the p.m. peak hour. As can be seen on the map, every arterial corridor has several deficient intersections. Any intersection operating at LOS E or worse is a likely candidate for HOV treatment.

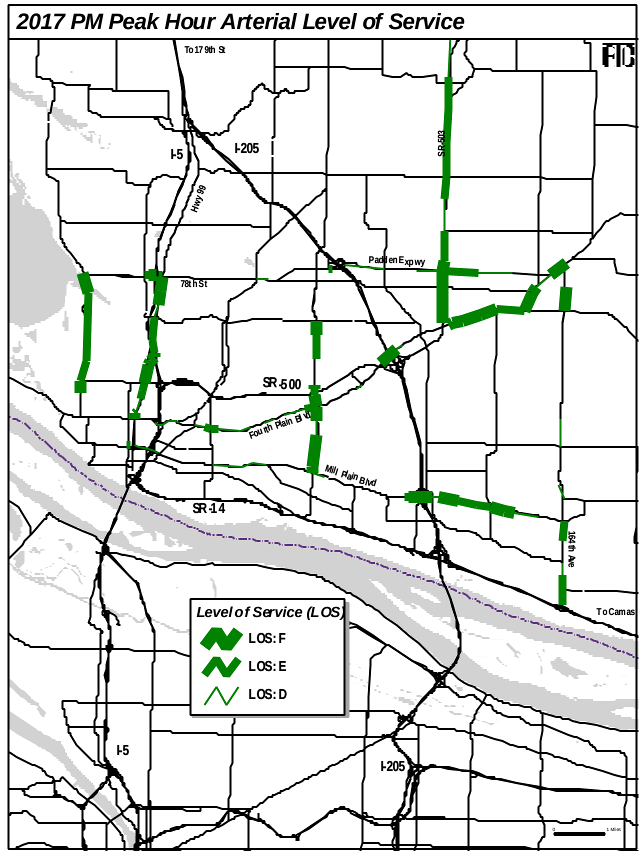


Figure 4-13: 2017 PM Peak Hour LOS

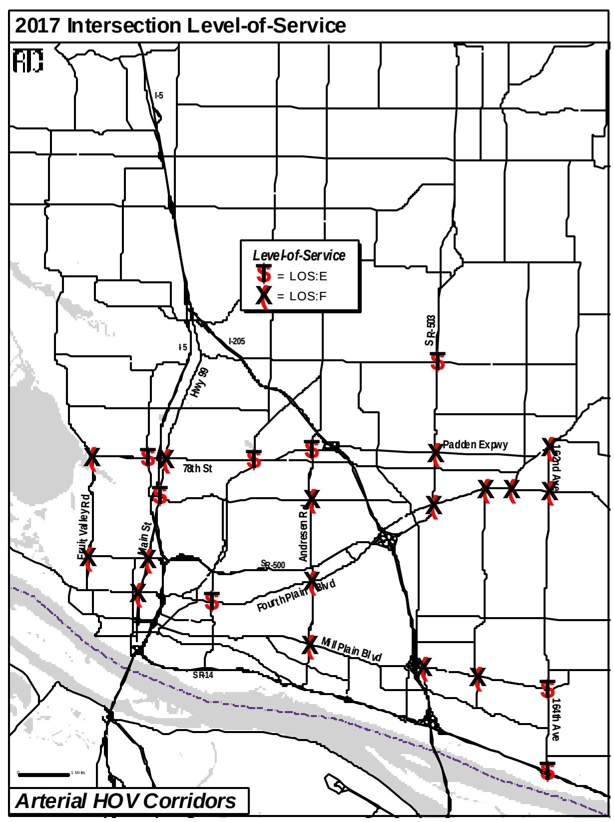


Figure 4-14: 2017 Intersection LOS

Transit Person Demand – Figure 4-15 provides an estimate on the number of transit persons projected for each of the arterial corridors. The highest demand occurs in the Fourth Plain Blvd corridor, with an hourly volume of 630 passengers at the western end of Fourth Plain. The south end of Main Street, where several bus lines converge as they approach the 7th Street Transit Center is the next highest with 520 passengers. Padden Parkway east of I-205 and 164th Avenue north of SR-14 also have high transit volumes. Those segments are used by several transit lines that are travelling between the freeway system and nearby park and ride lots whose access is located at the respective arterials.

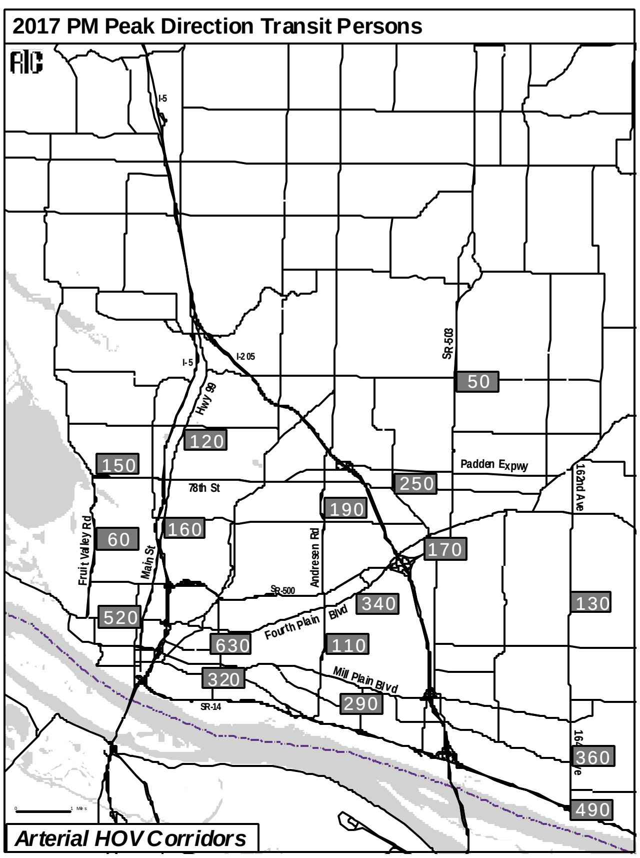


Figure 4-15: 2017 PM Peak Direction Transit Persons

b) Evaluation

This section contains a summary of the characteristics of the arterial corridors. Likely candidates for some form of arterial HOV treatment include corridors where intersection LOS is E or worse, planned bus service frequencies are in the range of 5 or more in the peak hour, and they have potential to benefit transit reliability and reduce bus delay.

78th/Padden (Fruit Valley Rd to Ward Rd)

Provides connection between HOV support facility at Central County park and ride and the HOV facility on SR-14. Peak bus volumes of 14 busses per hour east of I-205 and 7 buses per hour west of Highway 99.

Hwy 99/Main St (7th St to 134th St)

Travel forecast indicates LOS E to F for most intersections along the corridor. Bus volumes are significant. Eight busses per hour at the north end of the corridor and more than 30 busses at the south end near the 7th Street Transit Center. Could provide significant travel time savings and reliability for transit service

Fourth Plain Blvd (I-5 to 164th Ave)

Fort Vancouver Way, Grand Boulevard, and Andresen Road are projected to operate LOS E. Other intersections operate at LOS D but are approaching E. Six busses per hour during the peak period and C-TRAN's highest transit ridership line. Could provide significant improvement to transit reliability.

SR-503 (Fourth Plain to 219th St)

SR-503 has significant levels of congestion along the corridor, and SR-503 and NE 119th Street is forecast to operate at LOS E. Bus volumes are projected at only 2 per hour in 2017.

Mill Plain Blvd (Fourth Plain to 164th Ave)

Grand Boulevard and Andresen Road are projected to operate at LOS D and approaching E. Most of Mill Plain Boulevard from 104th Avenue to 164th Avenue is expected to operate at LOS E to F. Bus volumes range from 6 to 8 busses per hour during the peak period.

164th Avenue (SR-14 to Ward Rd)

Intersections between Mill Plain and SE 34th Street are projected to operate at LOS E. Complements HOV lane from SE 1st to SR-14. 14 buses are projected at the south end of the corridor.

<u>Fruit Valley Rd (Fourth Plain Blvd to 78th St)</u>

LOS E to F projected at 39th Street and 78th Street. Only 2 buses per hour are forecast along the facility.

<u>Andresen Rd (Mill Plain to Padden Parkway)</u>

The intersections of Andresen Road and Mill Plain Boulevard, Fourth Plain Boulevard, and 63rd Street are forecast to operate at LOS F in 2017. There are between 11 and 13 buses per hour projected between Vancouver Mall Drive and 78th Street.

E. DEVELOPMENT AND DESCRIPTION OF HOV ALTERNATIVES

1. Approach for Developing Alternatives

a) Freeways

As described previously in the development of the freeway facilities, a low corridor rating does not mean that HOV treatment should not be considered. It may affect the type of HOV treatment that may be appropriate. The corridor ranking, combined with the more detailed travel data, assisted staff in determining the type of HOV treatment to consider during the development of alternatives. The highly ranked corridors, I-5 and I-205, that exceeded the criteria described in Table 4-4 of this chapter were identified as corridors where HOV lanes should be considered.

In addition, the potential HOV bypass treatments at freeway on-ramps were assessed for all four corridors. The process analyzed 2017 freeway on-ramp volumes and the merging and weaving conflicts with the outside freeway lane and resulted in the determination of LOS (level of service) for the on-ramps. LOS analysis indicated that ramps operating at LOS E and above would result in significant delay and would warrant ramp bypass treatment. Ramps operating at LOS E or worse would provide 20 seconds and more travel time savings for HOV trips and were identified as locations with priority access for HOV.

b) Arterials

The approach taken for the development of arterial HOV facilities was different than for freeway HOV facilities. This was because, unlike freeway HOV facilities, arterial HOV will not generally encourage a shift to other travel modes. Arterial facilities cannot offer the same degree of travel time savings as freeway HOV due to the shorter trip lengths and more dispersed travel patterns on arterials compared to freeways. The arterial HOV policies provided the framework for which facilities were identified for potential HOV treatment. They are intended to emphasize the promotion of bus movement and transit reliability and to improve HOV connections between the arterial system and freeway HOV system. The policies state that arterial HOV facilities be considered as a traffic management policy that gives preferential treatment to buses but also provides support for HOV vehicles at their point of intersection with the HOV freeway system.

2. Description of HOV Facility Alternatives

The section describes the HOV facility alternatives for freeways and arterials. It comprises the alternatives that underwent detailed analysis and evaluation. The results of the detailed evaluation are contained in chapter V. The freeway and arterial HOV alternatives together formed the foundation for developing an HOV system plan concept shown on Figure 4-16.

The freeway HOV corridors include HOV lanes and ramp bypasses that can work in conjunction to provide good and reliable travel

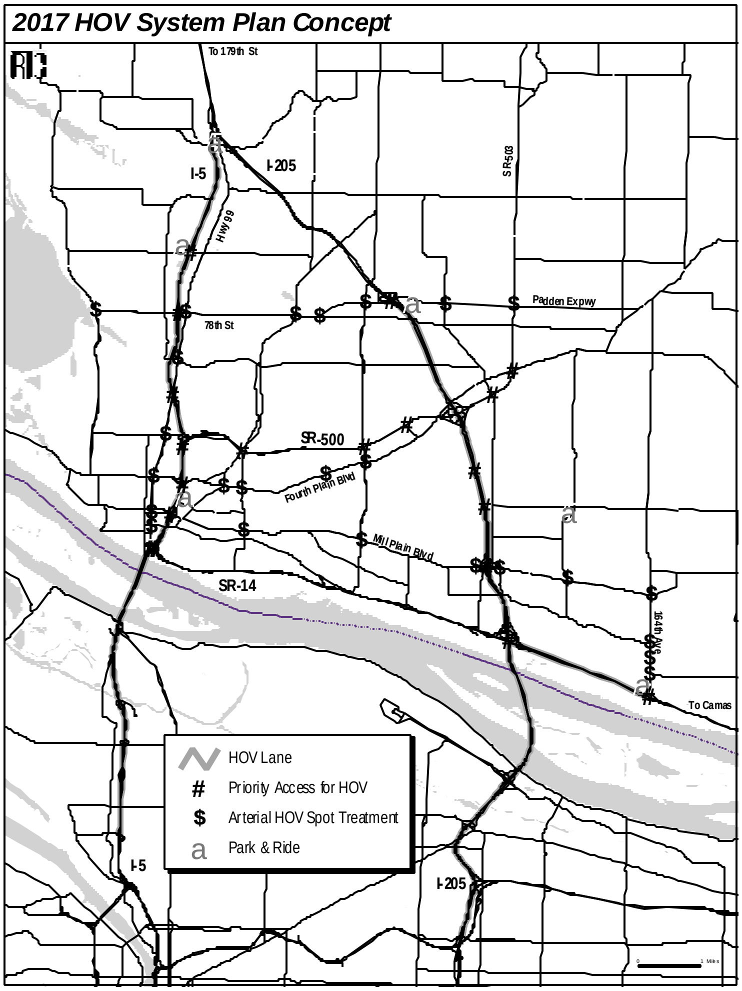


Figure 4-16: Clark County System Plan Concept

time savings for people who choose higher occupancy vehicle modes of travel with carpools, vanpools, and transit. Arterial HOV treatments can complement the HOV freeway system by promoting bus movement and transit reliability and supporting transit person travel along the arterial. In addition, arterial HOV will work in coordination with the HOV freeway system to increase transit reliability and improve mobility within the region for shared ride persons.

a) Freeways

The definition of the freeway alternatives began with assumption that HOV lanes will consist of concurrent buffer separated HOV lanes that would add capacity to the transportation system to accommodate HOV. This process was followed for the HOV lanes described below for the I-205 and SR-14 corridors. However, discussions with Oregon transportation agencies led to recognition of constraints in the I-5 corridor that would warrant a different assumption. The following section summarizes the rationale for modifying the original approach in defining the I-5 HOV alternative.

I-5 Corridor Approach - The I-5 Corridor HOV alternative being evaluated for this study is a change of the original design concept that consisted of adding new HOV capacity south of Main Street and providing HOV capacity by taking planned general purpose traffic lanes north of Main Street.

Concerns about adding new capacity for HOV along the length of the I-5 corridor included the following:

- It could affect traffic capacity and flows because of unbalanced capacity in the Vancouver portion of the corridor. There would be three lanes of general purpose traffic capacity south of Main Street Interchange and only two lanes of general-purpose traffic capacity north of the interchange.
- An HOV lane that adds capacity throughout the corridor to the Fremont Bridge would have a highly negative affect on the operation of the interchange at I-5 and I-405 and on the mainline operations of I-5 and I-405 south of the Fremont Bridge in Oregon.
- Current Oregon transportation policy does not support the addition of a through traffic lane in the I-5 north corridor.
- An added capacity HOV lane along the I-5 corridor would prevent the future consideration of other HCT modes in the corridor.

The modified concept results in one HOV and two general purpose travel lanes (in addition to auxiliary lanes) each direction in the I-5 corridor from 134th Street in the north to Going Street in north Portland. This alternative, described below, is considered an interim phased HOV option. It consists of converting general purpose travel lanes for HOV use in the section between Main Street Interchange and the Interstate Bridge. In discussions with WSDOT staff, there was consensus that the conversion of general purpose travel lanes for HOV use should only be considered as a phased approach to an ultimate HOV system. The I-5 HOV alternative analyzed for this study should be considered a project that would allow the option to consider other high capacity transit modes as long range strategies in the corridor, including HOV lanes, improved transit, or light rail transit. If HOV were selected as the long range strategy for the I-5 corridor, Clark County HOV policy should call for the provision of new roadway capacity to accommodate HOV lanes.

The policy issues associated with adding HOV capacity versus converting general purpose travel lanes for HOV use are described in chapter II. However, the I-5 HOV alternative for this study is described below.

I-5 Corridor

The I-5 corridor is described in detail because of lane additions and conversions.

134th Interchange to Main Street - HOV use of planned I-5 general purpose capacity improvement project. Adds one lane of new HOV capacity to existing cross-section.

Main Street to Interstate Bridge - No change to the existing cross section. Convert inside general purpose travel lane to HOV.

Interstate Bridge - New Columbia River Bridge with a total of one HOV lane and two general purpose travel lanes and an auxiliary lane in each direction.

Jantzen Beach to Interstate Avenue - No change to existing cross section. Convert inside general purpose travel lane to HOV.

Interstate Avenue to Columbia Boulevard On-ramp - Add new HOV lane by construction of new travel lane in each direction from north end of Columbia Slough overpass to south end of Columbia Boulevard overpass.

Columbia Boulevard On-ramp to Going Street - No change to the existing cross section. Convert inside general purpose travel lane to HOV.

Ramp bypass for HOV priority access would be located at 134th Street, 99th Street, 78th Street, Main Street, Fourth Plain Boulevard, and Mill Plain Boulevard

I-205 Corridor

The proposed improvement concept for HOV in the corridor consists of adding an additional traffic lane for inside lane HOV along the length of the corridor from 83rd Street/Padden Parkway to I-84. This corridor does not have the right-of-way constraints that are in the I-5 corridor and the addition of a travel lane in the corridor for HOV use would be relatively simple. The addition of an HOV lane on the Glenn Jackson Bridge could be accommodated but would narrow the shoulders on the bridge.

Ramp bypass for HOV priority access would be located at 83rd Street, 18th Street/28th Street, and Mill Plain Boulevard.

SR-14

This alternative consists of outside HOV lanes from I-205 to 164th Avenue and would function as a queue bypass lane for traffic destined to I-205 south. All the other HOV lane alternatives are inside HOV traffic lanes. Several characteristics support this segment for outside lane application: the short length of the segment, outside lane exit to I-205, no other access points between I-205 and 164th, and HOV ramp bypass for easy access into the HOV lane from 164th.

Ramp bypass for HOV priority access would be located at 164th Avenue, Ellsworth Road, Lieser

Road, Evergreen Boulevard, and Grand Boulevard

SR-500

No HOV lanes are proposed for SR-500. The planned grade separation of SR-500 will include an interchange at Thurston Way.

Ramp bypass for HOV priority access would be located at St. John's Road, Andresen Road/Thurston, 112th Avenue, and SR-503.

b) Arterials

This section describes the arterial components of an HOV system and addresses the major spot locations where arterial HOV treatment would be warranted based on 2017 travel forecast analysis. Arterial HOV improvements are separated into two categories park and ride lot access and other arterial intersections.

Generally, arterial HOV treatments were considered where: intersection LOS is E or worse, planned bus service frequencies are in the range of 5 or more in the peak hour, and they have potential to benefit transit reliability and reduce bus delay.

The type of HOV treatment at signalized intersections, for example signal priority or queue jump, is not identified. Intersections would need detailed operational analysis prior to implementation to determine the appropriate HOV intersection treatment.

Park and Ride Access

134th Street (Park and ride access to I-5 on-ramp) Provide bus priority treatment between park and ride lot and all traffic signals to I-5 on-ramp entrance.

99th Street (Park and ride access to I-5 on-ramp) Provide bus priority treatment between park and ride lot and all traffic signals to I-5 on-ramp entrance.

Visitor's Center (Park and ride access to I-5 on-ramp) Provide bus priority treatment between park and ride lot and all traffic signals to I-5 on-ramp entrance.

Padden Parkway (Park and ride exit to I-205 on-ramp) Provide bus priority treatment exiting park and ride lot to left turn to Padden Parkway and at all traffic signals to I-205 on-ramp entrance.

164th Avenue (Fisher's Landing park and ride access to 164th) Signal priority for busses between park and ride access and 164th.

Arterial Intersections

164th Avenue - Bus priority treatment at Mill Plain Boulevard, McGillivray Boulevard, SE 29th Street, and SE 34th Street.

Washington/Main Street and Highway 99 Bus priority treatment for all signalized intersections along the corridor from 7th Street to 78th Street.

Andresen Road Bus priority treatment at 63rd Street and 78th/Padden Parkway intersections with Andresen Road.

Fourth Plain Boulevard Bus priority treatment for all signalized intersections at Fort Vancouver Way, Grand Boulevard, Stapleton Road/54th Avenue, Andresen Road, Thurston Way. Other intersections should also be considered.

Mill Plain Boulevard Bus priority treatment at Grand Boulevard, Andresen Road, and all signalized intersections from 104th Avenue to 164th Avenue.

3. Operational Characteristics of the Alternatives

The operational characteristics described in this section apply to freeways and are dependent on the adoption of freeway operating policies that are outlined in chapter II, section C.3. of this report. Operating policies have not yet been adopted and their full definition and adoption will include stakeholders made up of the WSDOT, RTC, C-TRAN, local governments, the Washington State Patrol, general freeway users and the freight and environmental community. Operating policies need to be adopted prior to the implementation of an HOV system. The operational characteristics were used to set the freeway HOV operations for the system described in chapter VI. In turn, the HOV system plan will form the basis for a more comprehensive development of operating policies for an HOV system in Clark County.

a) Hours of Operations

Clark County HOV facilities are proposed as operating only during the peak period. The purpose of the peak period operation is to promote and support shared ride commuters. In addition, bi-state mobility on the interstate corridor is primarily a peak period problem. The HOV lanes would revert to general purpose use during the off-peak period. This would provide additional capacity during the midday for other non-work trips and would also improve mobility for freight traffic in the I-5 and I-205 corridors.

b) Carpool Requirement

Analysis indicates that initial occupancy requirements for a Clark County HOV system would be set at 2 or more persons per vehicle. This requirement is consistent with currently adopted WDOT operating policies. If HOV lane operations deteriorated because of high vehicle volumes, consideration would be given to either increasing the occupancy requirement or converting the HOV lane to high occupancy toll (HOT) use. A HOT lane, for example, could allow free use for vehicles with three or more people, but establish a fee for use of any vehicle carrying less than three people.

c) Enforcement

Enforcement procedures have not yet been defined but will need to be developed. At a minimum, agencies responsible for enforcement will be identified and consulted prior to the design and implementation of HOV facilities. This is to ensure that the HOV facilities allow smooth enforcement and that police agencies have the commitment to maintain safety and the use of the HOV lane by shared ride users.

d) Supporting Transit Service

Specific transit service is not defined, except that the HOV alternatives included significant transit service expansion as assumed in the adopted Metropolitan Transportation Plan. It includes extensive bi-state commuter service. In addition to the existing park and ride lots, lots are planned at the Visitors Center and at 99th Street in the I-5 corridor. The I-205 corridor includes planned lots at Fisher's Landing and Central County. In addition, freeway HOV policies in chapter II, section C.2. state that, "HOV support programs and facilities, such as carpool/vanpool programs, express bus service, and park and ride facilities, should be in place or planned for any transportation corridor being considered for HOV use".

CHAPTER V.
EVALUATION OF HOV ALTERNATIVES

This chapter summarizes the results of the evaluation of the HOV freeway alternatives described in the previous chapter. Section A compares a non-HOV system with the HOV freeway alternative and the impacts on the transportation system and traffic operations. This analysis focuses on the non-HOV and HOV system comparison; however, additional information was prepared that assumes additional general purpose capacity instead of HOV capacity in the I-5 corridor. The process for assessing the arterial HOV elements was more qualitative and is summarized in section B of this chapter. Sections C and D consist of a discussion of the air quality and land use associated with the HOV facilities.

A. HOV FREEWAY EVALUATION

Transportation system performance measures were developed for assessing the HOV freeway alternatives. They were intended to assist in evaluating the effectiveness of the HOV freeway alternatives and consist of both regional and corridor level measures. The regional measures address the impact of the HOV system alternatives on the regional transportation system by providing information on regional mode split, vehicle miles of travel, and vehicles hours of delay. The corridor measures focus on effectiveness of the HOV alternatives by assessing their impact on congestion and traffic operations within the corridor. Both regional and corridor measures are divided into three elements of transportation system performance and include developing information on the impacts of the alternatives on person travel, vehicle travel, and mobility. Table 5-1 displays the performance measures used to evaluate the transportation impacts of the freeway alternatives.

The transportation analysis was conducted using a 2017 travel forecast. The travel forecast is based on the adopted comprehensive land use plans and on the projected 2017 land use. The highway improvements for the non-HOV system assumed in the travel forecast consist of the projects contained in the currently adopted Metropolitan Transportation Plan. The I-5 non-HOV and the added general purpose options are identical except that the general purpose option has additional capacity across the Interstate Bridge and through Delta Park. The capacity improvements assumed for the HOV freeway alternative is summarized below. In addition, the transit service assumptions for the HOV option are consistent with the planned transit service improvements contained in the MTP.

1. Summary of HOV Freeway Alternatives

This section has a short summary of the lane configuration for the HOV freeway component of the HOV system plan. A full description of the alternatives including HOV ramp bypass treatments is described in the previous chapter.

<u>I-5 Corridor</u> – The I-5 option is primarily a lane conversion option. New general purpose capacity planned north of Main Street is assumed as HOV capacity. New capacity is provided for HOV lanes across the Columbia River and through Delta Park. The remainder of the corridor south of Delta Park converts a general purpose travel lane to HOV use.

<u>I-205 Corridor</u> – The I-205 option adds a new lane of capacity for HOV use from 83rd Street in the north to I-84 at the south end of the corridor.

<u>SR-14 Corridor</u> – SR-14 adds an outside HOV lane from I-205 to 164th Avenue to provide improved access to I-205.

Table 5-1: Transportation System Performance Measures: HOV Freeway Evaluation

Measure		Description
Regional Measures		
Persons	Number and percentage of persons shifting from driving alone to: • Carpooling • Transit	Measures the regional shift from driving alone to other travel modes (carpooling and transit).
Vehicles	Change in VMT for: • Drive alone vehicles • HOV vehicles	Provides another indicator of regional mode shift by measuring vehicle miles traveled for single occupant vehicles and HOV vehicles.
Mobility	Change in VHD for: • Drive alone vehicles • HOV vehicles • All vehicles	Measures overall changes in regional mobility by mode and for all vehicle trips.
Corridor Level Measures		
Persons	Person Demand in: • General purpose travel lanes • HOV travel lane	Measures total person demand in the corridor and compares person carrying efficiency by facility type.
Vehicles	Vehicle Volumes for: • General purpose travel lanes • HOV travel lane • All lanes	Compares congestion levels for general purpose and HOV travel lanes and impacts to overall congestion in the corridor.
Mobility	Average peak hour travel speed and time for: • General purpose lanes • HOV lane	Compares travel time and speed differences between the general purpose and HOV lanes and the productive person throughput in the corridor.

2. Transportation System Performance

Transportation system performance measures focus on the overall impact to the regional mobility by comparing changes to persons and vehicle travel to Oregon and within Clark County as a result of the HOV system. Section a) looks at the changes to modal share for travel to Oregon, section b) addresses the impact of the HOV system on vehicle hours of delay, and section c) describes changes to vehicle miles traveled.

a) All Day Travel Demand

As discussed earlier in the report, the most important factor that determines the potential benefit/use of an HOV facility is the travel time savings benefit for the user. Earlier analysis indicated that in order to achieve the needed time-savings, a bi-state HOV system which serves the longer commute distances needed to make HOV attractive is critical. The next four figures show all day bi-state trips by mode for Clark County commuters traveling to Oregon and to the Portland central city. The central city consists of the downtown Portland freeway loop and the Lloyd District northeast of downtown. These tables do not include freight traffic or trips that travel through the Vancouver/Portland metropolitan region.

Figures 5-1 and 5-2 display bi-state travel and the change in the characteristics of travel to and from Oregon compared to a non-HOV system. The number of

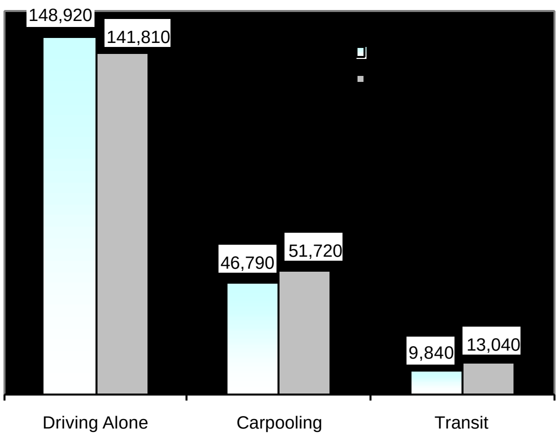


Figure 5-1: 2017 Clark County to Oregon – Person Travel

people traveling from Clark County to Oregon has increased slightly, by 1,000 trips, but the number of vehicles crossing the Columbia River from Clark County has been reduced by more than 9,000 cars, a decrease of about 3% compared to a non-HOV system.

The addition of only general-purpose capacity in the I-5 corridor results in a shift to drive alone trips, a slight increase in shared ride trips and a 30% decrease in transit travel to Oregon compared to the non-HOV system.

The mode share of travel across the Columbia River has also changed. In the HOV alternative, 68.6% of the trips to Oregon are comprised of people driving alone. This represents a 4.8% reduction in drive alone travel from the base case. People in carpools and vanpools make up 25% of the travel to Oregon, a 10.5% increase in the number of shared ride trips from the base case. Travel by transit accounts for 6.4% of cross-river travel, an increase of transit trips of more than 32%. An analysis of vehicle travel (Figure 5-2), not counting bus vehicles, shows a change in the vehicle mix with a shift toward shared ride vehicles. More person travel is occurring across the river with fewer vehicles, resulting in better bi-state accessibility.

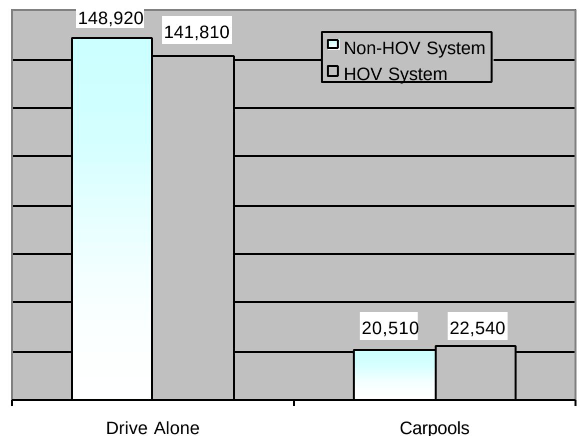


Figure 5-2: 2017 Clark County to Oregon – Vehicle Travel

Figures 5-3 and 5-4 display travel to and from central Portland. The trends are similar to travel to Oregon, but are much more pronounced. As may be expected for the HOV system, the percentage of people travelling to central Portland on transit is significantly higher than for travel to Oregon, 30.6% and 6.4% respectively.

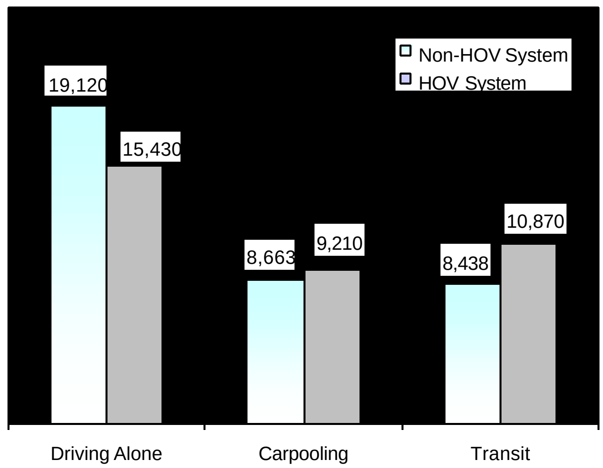


Figure 5-3: 2017 Clark County to Central City - Person Travel

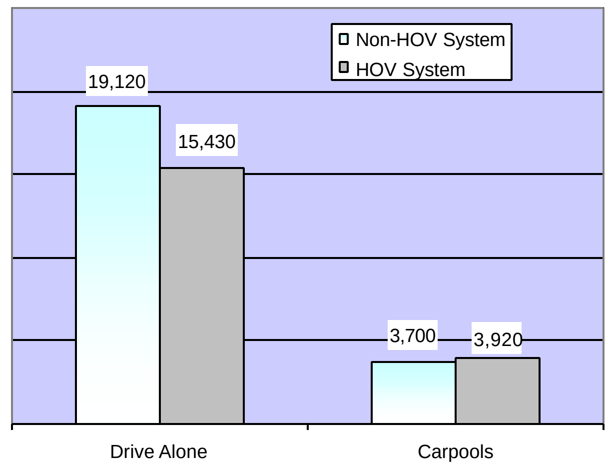


Figure 5-4: 2017 Clark County to Central City - Vehicle Travel

The non-HOV system has 23% transit travel to central Portland. The percentage of people driving alone to downtown Portland under the HOV system is 43.4%. Drive alone travel should be lower to downtown than to other Oregon destinations because of congestion, high parking costs, and poor accessibility, However, for the HOV system this represents a 19.3% decrease in the number of people from Clark County driving alone to downtown Portland when compared to the non-HOV scenario. The percentage of people from the County carpooling to central Portland is 26%; a 6% increase compared to the non-HOV base condition.

The impacts of I-5 general purpose expansion show the same trends as travel for Clark County to Oregon travel. There is a shift to drive alone trips with a significant decrease in transit travel compared to the non-HOV system.

The decrease in the number of people driving alone to Portland combined with an increase in carpool vehicles results in 19,340 cars entering the Portland central city from Clark County, 15.2% lower than the non-HOV base.

Transit, which provides extensive fixed route express commuter bus service to the Portland core, is the favored alternate mode of travel. The carpool mode appears to be the alternative mode of choice for travel to destinations other than the central city. It showed the highest numerical increase in person travel for trips between Clark County and Oregon compared to other modes. Carpooling allows greater flexibility to serve multiple and more dispersed destinations compared to transit.

b) Vehicle Hours of Delay

Figure 5-5 shows AM peak hour vehicle hours of delay for the Clark County highway system. Vehicle hours of delay depicts excess time experienced by all vehicles on the transportation system. This is determined by calculating the additional delay on roadway segments under congested conditions when travel speed falls below 70% of free flow conditions.

The hours of delay shown in the following figure compares delay on a non-HOV and HOV highway system. This performance measure looks only at the delay on the Clark County system as a whole. Therefore, while there may be reductions in system delay, individual corridors or segments may experience higher levels of congestion. Facility specific issues will be discussed in the following section on traffic operations.

SR-14 is the only principal arterial with HOV lanes and Figure 5-5 shows some decrease in delay for HOV vehicles on principals. As expected, changes to delay occur on the interstate facilities, where the HOV lanes are located. On a system wide basis, HOV vehicles that are previously mixed in the general purpose traffic stream now have a traffic lane for their exclusive use resulting

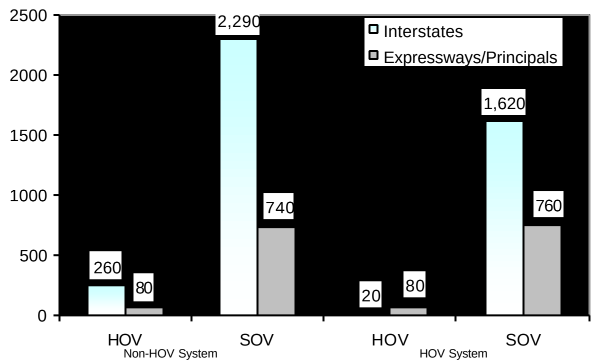


Figure 5-5: 2017 A.M. Peak Hour Vehicle Hours of Delay - Clark County Highways

in very limited delay for carpools. Delay for single occupant vehicles (SOV) also decreases by a significant margin, because on a system-wide basis, highway capacity has been added to provide the HOV lanes, specifically along the I-205 corridor, and the Interstate Bridge and Delta Park in the I-5 corridor. Shifting HOV vehicles out of the general purpose travel lanes opens up capacity and results in reduced delay for drive alone vehicles.

I-5 general purpose lane expansion results in less overall delay than the non-HOV system. Delay on the interstate system is reduced, but higher on the principle and expressway system because of the additional trips on the arterials feeding I-5.

c) Vehicle Miles Traveled

Vehicle miles traveled (VMT) is a function of the number of vehicles on the transportation system and the distance they travel on the transportation system. Figure 5-6 shows the VMT on Clark County highways and compares the non-HOV and HOV networks.

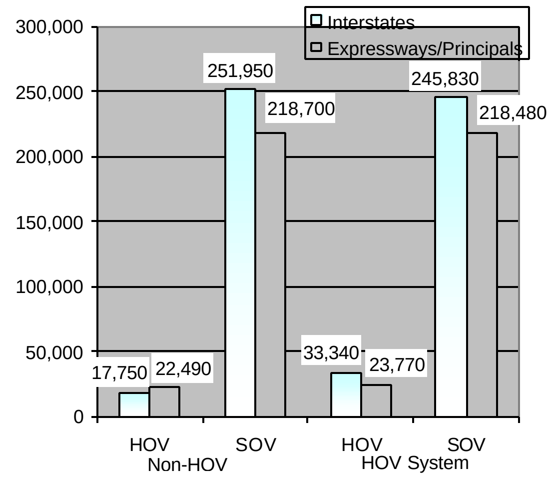


Figure 5-6: 2017 A.M Peak Vehicle Miles Traveled - Clark County Highways

Little change is indicated on principal facilities with significant differences appearing on the interstate system where most of the HOV lane miles are located. The VMT for HOV vehicles almost doubles with the HOV alternative. This is due to the overall increase in HOV vehicles on the transportation system. In contrast, the number of lane miles for use by general purpose traffic has decreased due to HOV lane conversion on I-5. The VMT for I-5 added general purpose capacity is almost identical to the non-HOV system.

A review of the transportation analysis described above indicates that the overall performance of the Clark County transportation system improves with the HOV alternative.

3. Traffic Operations

This section describes traffic operations issues associated with HOV facilities. Part a) reviews the impact of the HOV alternative on vehicle volumes and travel speeds. Part b) analyzes traffic volumes for the freeway to freeway connections to assess the potential need for dedicated HOV ramps to I-5 and I-205. Part c) summarizes other traffic operations issues for HOV lanes: inside versus outside HOV lanes, all day versus peak period HOV designation, and the use of HOV lanes by commercial vehicles.

a) Corridor Volumes and Speed by Lane Type

The map in Figure 5-7 compares vehicle volumes and travel speeds for 2017 AM peak hour southbound travel on the I-5 and I-205 corridors for the non-HOV and HOV systems. It provides a general picture of traffic operations in the corridor and provides information on vehicle demand and travel speeds on the HOV lane and the adjacent general purpose travel lanes Vehicle volumes shown on the map do not include transit buses, which could increase volumes in the HOV lane by six to twenty six buses per hour in 2017 depending on the corridor and location being analyzed.

<u>I-5 Corridor</u> – Beginning at the north end of the corridor, analysis indicates that traffic volumes in both the general purpose and HOV lanes progressively increase as the corridor continues south to the I-5 Bridge. The HOV lane operates at a speed that ranges between 48 m.p.h. to 55 m.p.h. in all segments except for the Interstate Bridge where HOV volumes are the highest with 1,650 vehicles and speeds are slowest at 40 m.p.h. The Interstate Bridge segment also has a speed differential of 32 m.p.h between the HOV lane and the adjacent traffic lanes. The freeway segment with the highest speed difference is between SR-500 and Fourth Plain Boulevard with a variance of 37 m.p.h. Travel speeds in the general purpose lanes decrease in most segments due to the HOV alternative. North of 39th Street, for example, a.m. peak speed is 27 m.p.h. in the non-HOV option compared to 22 m.p.h. for the HOV alternative. This is due to the conversion of a general purpose travel lane for HOV use in the corridor.

All the segments in the I-5 corridor carry more vehicles in a non-HOV alternative than the HOV alternative, including the Interstate Bridge, where capacity for an HOV lane has been added. There are 8,140 vehicles on the bridge without HOV compared to 7,930 vehicles with HOV.

Although vehicle volumes in the corridor under the HOV alternative are lower, analysis indicates that person throughput (not including transit persons) traveling in the corridor are higher, even in segments where a mixed traffic lane has been converted to HOV. This is illustrated in the following example. The occupancy for drive alone vehicles is 1 and the travel forecast estimated the occupancy for shared ride vehicles at 2.29. If these factors are applied to drive alone and HOV vehicles to the segment north of Fourth Plain Boulevard, a lane conversion segment, the HOV alternative carries 9,890 people compared to 9,640 people for the non-HOV option.

There is also a marginal difference in average vehicle volumes per general purpose travel lane between an HOV and non-HOV system with all segments displaying a difference of no more than 190 vehicles per hour. The exception, again, is the Interstate Bridge where a new lane of capacity is being added. The non-HOV option carries 2,710 vehicles per lane compared to 2,090 for the HOV option.

The addition of general purpose capacity in the I-5 corridor attracts slightly higher volumes in the corridor north of SR-14 compared to the non-HOV system due to the increased capacity from the Interstate Bridge south. Speeds are also very similar to the non-HOV system.

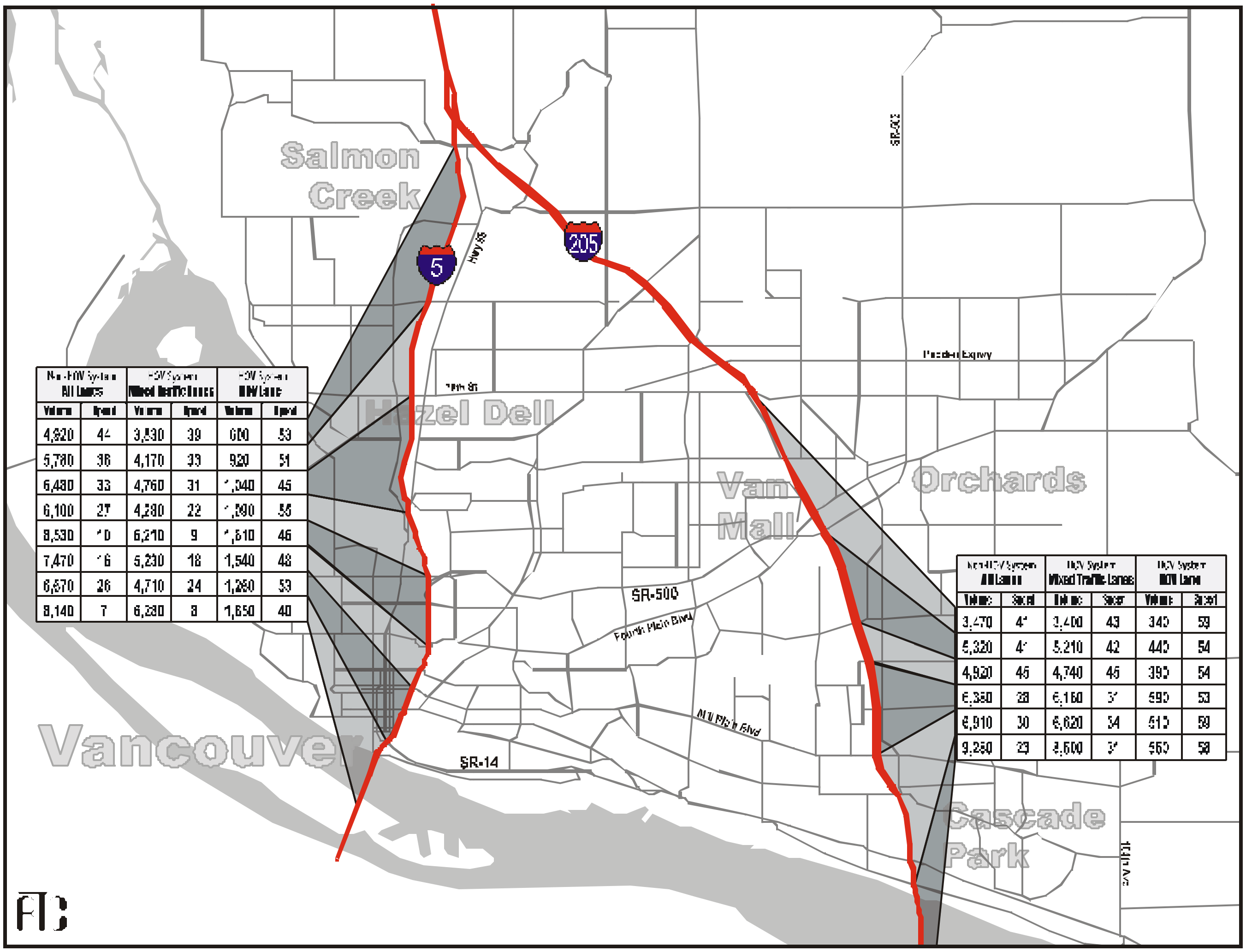


Figure 5-7: 2017 Corridor AM Peak Volumes and Speeds

<u>I-205 Corridor</u> – Like the I-5 corridor, traffic volumes in both the general purpose and HOV lanes progressively increase as the corridor continues south to the Glenn Jackson Bridge. The HOV lane on I-205 operates at a higher speed than the lane on I-5 due to lower volumes. The speed ranges from 53 m.p.h. to 59 m.p.h. in all segments including the Glenn Jackson Bridge. The speed differential between the HOV lane and general purpose traffic lanes are lower for I-205 than I-5, primarily because of the higher congestion levels and lower speeds on I-5. The highest speed difference in the I-205 corridor is on the Glenn Jackson Bridge with a variance of 27 m.p.h.

The I-205 HOV option assumes a new lane of capacity along the length of the corridor; therefore, in contrast to the I-5 corridor, the HOV alternative in the I-205 corridor carries more total vehicles than the non-HOV alternative. North of Fourth Plain, for example, there are 6,750 vehicles in the peak hour compared to 6,380 vehicles without HOV. The exception to this is on the Glenn Jackson Bridge where total volumes are slightly less with an HOV lane. A comparison of only the general purpose traffic lanes indicates lower volumes and higher speeds with the HOV option than the non-HOV option. Because of the lane addition, carpool trips are being shifted out of the mixed traffic lanes to the

HOV lane and opening more capacity in the general purpose lanes.

In addition to carrying more vehicles in the I-205 corridor, the HOV option also has more person through put than the non HOV option. If the factors described in the previous section are applied to the segment north of Mill Plain Boulevard, the HOV alternative carries 7,500 people compared to 6,380 people for non-HOV.

Travel Patterns - Another aspect to the change in travel under an HOV scenario is a general shift of both drive alone and carpool vehicles from I-205 to the I-5 corridor. In the non-HOV option there are 900 carpool vehicles mixed with drive alone traffic crossing the Glenn Jackson Bridge. With HOV in the corridor, there are only 560 carpool vehicles crossing the bridge. For carpoolers destined to downtown Portland, I-5 is the corridor of choice. I-5 HOV offers high speeds and reliability with an HOV lane that terminates in close proximately to the Fremont Bridge. In contrast, the I-205 corridor HOV lane terminates at I-84 which means that I-205 carpoolers would be in mixed traffic from I-84 west to Portland. In addition, the provision of new capacity on I-5 from the bridge through Delta Park causes some drive alone traffic to shift to I-5 from I-205.

The information in this section indicates the need for a more detailed traffic flow analysis of potential problems in the corridors. The analysis would need to identify merging and weaving conflicts between the HOV lane and adjacent general purpose traffic, the merges between freeway on-ramps and the freeway mainline and access to the HOV lane, and safety problems due to speed differential between the HOV lane and adjacent traffic lanes.

b) Analysis of Freeway to Freeway HOV Connections

The purpose of this section is to describe potential issues for the freeway connections to the I-5 and I-205 HOV corridors. It addresses traffic operations that could affect the ability of carpools to safely access the mainline HOV lanes from other freeway facilities by reviewing carpool demand and congestion levels at those locations.

The areas described below will need detailed operational analysis to determine whether high capital construction elements, such as grade separated HOV connections, are needed. Any potential grade separated treatments would require technical engineering review to determine their feasibility. In addition, any grade separated connections are likely to have a significant capital cost and would have to be assessed for their overall benefit to the transportation system.

I-5 and SR-500 - I-5 just south of SR-500 is projected to experience significant congestion levels (LOS F) in 2017 AM peak period travel forecasts. The LOS for the SR-500 on-ramp to I-5 south is also projected at F. This could result in a difficult merge movement from SR-500 to I-5 south for HOV vehicles attempting to access the inside HOV lane on I-5. Analysis of demand from SR-500 shows that there are about 500 HOV vehicles, 17% of all vehicles, in the AM peak hour going south on I-5 and crossing the Interstate Bridge. A grade separated HOV ramp from SR-500 to I-5 south would allow carpools, vanpools and busses direct access into the HOV southbound lane. Without separate access for the HOV movement, shared ride vehicles from SR-500 would have to cross several travel lanes before merging into the HOV lane. Merging/weaving resulting from the movement could result in increased delay and reduced safety in this segment of the corridor.

I-5 and SR-14 - This location is similar to the issues as described in the previous section and could result in the consideration of grade separation for the HOV movement from SR-14 to I-5 south. Total HOV demand from SR-14 to I-5 is also also about 500 vehicles per hour, but comprises 37% of the vehicle demand from SR-14. The I-5 HOV alternative assumes new bridge capacity across the Columbia River to accommodate an added HOV lane. There may be potential to incorporate a dedicated ramp with a new bridge configuration; however its feasibility would need to be analyzed.

I-205 and SR-500 - Preliminary analysis indicates that on-ramps from SR-500 to I-205 south are expected to operate at an acceptable LOS D. SR-500 is not proposed for HOV lane treatment and shared ride traffic demand from SR-500 destined to the Glenn Jackson Bridge is relatively low with 100 vehicles per hour. In addition, projected AM traffic volumes along the I-205 mainline just south of SR-500 indicate that merging left to an inside lane on I-205 should be relatively simple.

I-205 and SR-14 - The HOV segment on SR-14, which has an outside HOV lane, is intended to provide continuous HOV access to I-205. This would allow SR-14 HOV traffic to more easily split from SR-14 to I-205 south. Another merge to the left by HOV traffic would be required from the on-ramp to the center HOV lane on I-205. There are approximately 200 HOV vehicles accessing I-205 south from SR-14 to the east, and although the general purpose travel lanes on I-205 are experiencing congestion, mainline travel speeds are 31 m.p.h. Because of the relatively low HOV volumes for this movement, dedicated ramp treatment is likely not warranted.

I-205 and I-84 - An inside lane HOV facility on I-205 would require that shared ride vehicles from I-205 would have to travel across general purpose traffic lanes to access I-84. This could result in leaving the HOV lane significantly north of I-84 to ensure that the exit can be accessed. One potential way to address this movement is with an outside lane HOV facility. This approach may not be feasible due to the high number of general purpose vehicles entering and exiting the freeway between the Columbia River and I-84. Operational analysis will need to assess how an inside lane HOV affects this segment.

c) Other Operational Issues

Inside versus Outside Lanes - The two options for the placement of freeway HOV lanes is on the inside or outside lanes of the freeway facility. Transit operators generally prefer outside HOV lanes; however, only about 10 percent of HOV lanes in the United States are located on the outside. For the transit operator, the outside lane eliminates the need to merge across several general purpose travel lanes to reach the HOV lane. This movement is difficult for buses because of their size, slower speeds and acceleration ability; however, outside lanes cause other problems for transit vehicles. Buses and carpools in an outside lane are in constant conflict with the general purpose traffic entering and exiting the freeway. The merging and weaving resulting from this movement could cause increased congestion in the corridor. Outside lanes are most feasible where there is little or no access along the facility. A good example of this is on SR-14, which would consist of an outside lane HOV. There is no freeway access on SR-14 between 164th and I-205. Because of its short distance, the lane could function as a queue bypass that avoids the congestion the on SR-14 to access I-5.

Despite the drawbacks of an inside lane that forces buses and carpools to weave across general purpose travel lanes, this is less of an issue for longer distance commute trips. For the long haul freeway trips, conflicts with general-purpose traffic are greatly reduced and there is more opportunity for a safe merge into and out of the HOV lane. Without direct access, short distance transit and carpool trip would find it difficult to use an inside HOV lane in a congested corridor.

All Day versus Peak Period HOV Designation - Allowing general-purpose use of an HOV lane during the off peak period would not have a negative impact on traffic operation. However, in using the lane for HOV only during the peak period, the public could perceive this as taking a lane from most drivers (for carpools) at a time when the system is most congested. A peak period only lane can also lead to driver confusion and higher violation rates because of the changing hours of use. The consideration of HOV in the I-5 or I-205 corridors may be unique from the HOV experience in the Puget Sound area and peak period HOV could be more appropriate for this region. First, both corridors, especially I-5, are very congested for several hours each day, but mainly during the peak period. The level of congestion in the corridor can offer reliable travel time for shared ride trips. Second, right of way in the I-5 corridor is very constrained, the hybrid HOV option has only two general purpose travel lanes resulting in very limited mobility for drive alone travelers. Opening the HOV capacity to general purpose use during the off-peak period would occur at a time when there would otherwise be little travel time difference between the HOV lane and general purpose travel lane, and therefore, no incentive for HOV use. In addition, it would benefit midday traffic operations in the I-5 corridor for all users of the transportation system, including freight.

<u>Commercial Vehicle Use of HOV Lanes</u> - The exclusive use of an HOV lane for trucks during off-peak periods is uncommon, even though there is very limited negative impact to overall traffic operations resulting from freight use of an HOV lane during the off-peak. The trucking industry is very reluctant to support this strategy. Their primary concern is public resentment feeling that the inside lane should be reserved for the public and not for a particular user group. The more common practice in some areas is an outside heavy vehicle lane used by trucks and buses. This can work well in areas where there are no auxiliary lanes and limited access points along the facility.

4. Air Quality Issues

a) Potential Regional Air Quality Impacts of HOV Facilities

There is continuing debate on the regional air quality impacts of HOV facilities. The Environmental Protection Agency identifies HOV lanes as a transportation control measure. Transportation control measures consist of those transportation activities that result in decreased travel by single drivers or shift travel out of the peak period resulting in lower emissions. Other control measures include activities such increased transit service, vanpool and carpool programs, and employer trip reduction programs.

Studies have shown that HOV lanes have increased regional and corridor rideshare rates, increased transit ridership, and improved person throughput in transportation corridors. Some of these benefits are described in Chapter II, Section D. As the analysis of traffic operations in the previous section indicates, however, there may be trade-offs in the corridor or at specific locations that result in reduced travel speeds for general purpose traffic. In addition, while increased travel speeds for carpools in an HOV lane result in lower emission from volatile organic compounds, it can also result in higher nitrous oxide emissions.

A study on HOV lanes by the Chesapeake Bay Foundation titled *Re-Thinking HOV - High Occupancy Vehicle Facilities and the Public Interest* addressed the question of whether building HOV lanes improves air quality. The study reviewed previous studies on the subject and found that although HOV lanes can improve air quality there is no single answer. HOV lanes do achieve reductions in congestion and in vehicle miles traveled, but HOV lane construction can be an expensive air quality measure and other measures for the purpose of improving air quality may be more cost-effective. The study also refers to analysis that found that new HOV lanes would substantially increase carpooling, but that total vehicle miles traveled would be only slightly less than if the same mileage of general purpose lanes had been built. One of the conclusions of the study is that "HOV lanes are a congestion-dependent transportation improvement; they only work well when the main freeway lanes are highly congested. Unless the HOV lane offers a minimum of 5 to 10 minutes of travel time savings, its success can be expected to be marginal at best."

Another air quality issue associated with HOV lanes is that ridesharing or a shift to transit can take some additional driving. Picking up carpoolers or a trip to the park-and-ride can lengthen the overall journey to work. Driving to a park and ride lot or to pick up a passenger still requires a vehicle start. As much as half of an average trip's pollution is during the engine's warm-up ("cold start") and cool-down ("hot soak"). So while carpools can improve air quality, other strategies that eliminate vehicle starts or reduce driving may be more effective.

b) Air Quality Conformity

Transportation Plan and Program Conformity - The Federal and State transportation conformity regulations require that mobile source emissions resulting from implementation of the Metropolitan Transportation Plan (MTP) and the Transportation Improvement Program (TIP) meet criteria to ensure compliance with the provisions of the Clean Air Act of 1990 (CAA). The CAA outlines a process to insure that metropolitan regions remain within clean air standards, known as the National Ambient Air Quality Standards (NAAQS). For the Vancouver air quality area, a mobile emissions budget has been established that defines the amount of allowable region-wide emissions from vehicle transportation in the region over a ten year period while still maintaining air quality standards. The emission budgets are defined in the Ozone and Carbon Monoxide Maintenance Plans.

Conformity would have to insure that any HOV facilities included in the MTP or the TIP in combination with other transportation projects contained in the plan and program would remain within the mobile emission budgets. For the Ozone Plan, emission budgets have been defined for volatile organic compounds and for nitrous oxide.

Carbon Monoxide Project Conformity - In addition to plan and program conformity, project level air quality conformity analysis must also be conducted. Before an HOV facility can be implemented, the localized impact of the project on carbon monoxide emissions must be analyzed. This is also know as 'hot spot' analysis of the facility which insures that a stand alone project, not combined with others like plan and programs, meets air quality standards for CO. The arterial intersection HOV improvements identified as part of the HOV alternatives that result in modifying roadway configuration will also need to have project conformity analysis conducted. As described in chapter IV, section D the type and scope of HOV improvements at arterial intersections will be based on detailed operational analysis. The need for conformity analysis will be determined after the HOV project definition is completed.

5. Land Use

HOV can support existing activity centers by providing improved access for shared ride commuters to activity centers, especially the high density activity centers for the transit commuter. It can also support lower density employment centers that are located along an HOV corridor and are generally areas that are less well served by transit. An employment center without transit service and with good access from an HOV facility can be well served by the carpool commuter market. A review of the transportation system operations analysis in Section A.2. of the chapter indicates that while the primary shared ride market to high density areas is by transit, carpooling is the preferred mode for the more dispersed low density activity centers.

There is no evidence that HOV facilities actively benefit or influence higher density transit supportive development. Because the transit market for HOV is limited to the longer distance commuter trips, there is likely little direct impact on land use patterns or development to promote high densities. HOV facilities may support existing land use and will likely not conflict with adopted plans but will not promote high densities. Since HOV lanes make commuting easier and quicker for shared ride users, their availability could encourage housing and job choices that require long commutes but the land use impact is indeterminate.

The more direct land use impact of HOV lanes may be more localized. Support facilities needed for HOV lanes may affect land and development in a specific area. The need for a park and ride facility for example, may affect existing buildings or may not be compatible with existing development and planned land uses.

B. PROCESS FOR EVALUATING ARTERIAL FACILITIES

Section C.4. in chapter III describes the arterial policies and provides the main guidance on the consideration of arterial HOV facilities. The policies state that arterial HOV facilities be considered as a "traffic management policy that gives preferential treatment to buses" but also "provides support for HOV vehicles at their point of intersection with the HOV freeway system." The arterial HOV policies provide the framework for which facilities are identified for potential HOV treatment. They are intended to emphasize the promotion of bus movement and transit reliability and to improve HOV connections between the arterial system and the freeway HOV system.

Arterial HOV corridors underwent a different evaluation process than the freeway corridors. Performance measures were not developed for the HOV arterial corridors. Arterial segments and locations were determined by examining travel data and transit bus demand in the corridor and at individual intersections. This process resulted in the identification of HOV arterial segments and locations proposed for HOV treatment which are described in chapter IV, section E.2.

There is a wide-range of HOV spot treatments that can be applied at arterial intersections and other locations and no specific treatment is proposed except to identify locations. Detailed operational analysis will need to be conducted to determine the most effective arterial HOV treatment for each location. The type of HOV treatment at signalized intersections, for example signal priority or queue jump, is not identified. The detailed analysis would determine the type and amount of signal priority for bus movement and the impact on the operation of non-HOV traffic using the intersection. It will include balancing mixed flow traffic needs with the traffic management objectives to establish priority for transit person travel. That detail of analysis will not be done for this study but will need to be conducted prior to implementation of any arterial HOV treatments.

Generally, arterial HOV treatments were considered where: intersection LOS is E or worse, planned bus service frequencies are in the range of 5 or more in the peak hour, and they have potential to benefit transit reliability and reduce bus delay.

The analysis resulted in the identification of several corridors where arterial facilities met the threshold for arterial HOV treatment would be justified. Intersection HOV treatments are identified along all or portions of the following corridors: 164th Avenue, Washington/Main Street and Highway 99, Andresen Road, Fourth Plain Boulevard, and Mill Plain Boulevard.

C. COST AND FINANCING ISSUES

1. Capital Cost Estimates of HOV System Plan

This section addresses the potential cost of the HOV system plan described in section E of chapter IV. The capital cost estimates in part a) of this section were developed at the sketch planning level and should be considered only order of magnitude estimates. They are based on a preliminary review of the corridors and identification where there may be the need for additional right of way, noise walls and other costs elements. There are numerous factors that may affect cost that are unknown and are not accounted in these estimates. In addition, there are potentially complex considerations that would need to be addressed during the design concept stage of HOV corridor development. Cost estimates were developed only for elements of the system plan that affect transportation facilities. For example, the estimates do not include the cost of new buses that may be needed to provide additional service in the HOV corridors. They also do not include any additional cost for park and ride construction. The park and ride lots identified in the system plan are currently programmed, planned or under consideration for development.

The HOV capital cost estimates were derived through consultations with staff from the Washington State Department of Transportation and the Oregon Department of Transportation. For new HOV lane construction, including the Glenn Jackson Bridge, WSDOT developed an HOV Cost Estimate Worksheet that was used to estimate capital costs for a full build HOV system for I-5, I-205 and SR-14 in the Vancouver Urban Area. The worksheet included unit costs for the cost components of HOV lane construction. For portions of the system that consisted of conversion of general purpose travel lanes for HOV use, staff from the ODOT were consulted regarding the costs the I-5 North HOV Pilot Project. The Pilot Project began in October 1998 and converted a general-purpose travel lane to HOV use from Going Street to Columbia Boulevard. From Columbia Boulevard north to Marine Drive, the structure was restriped and shoulders were rebuilt to accommodate an additional travel lane for HOV use with inside and outside shoulders. Cost elements for lane conversion consisted primarily of painting, striping and sign bridges.

HOV lane addition for I-5 from Main Street to 134th Street was based on I-5 widening project costs contained in the Metropolitan Transportation Plan.

Interstate Bridge replacement costs were initially developed from the New Bi-state Transportation Facilities Capital Facilities Cost Report. Bridge replacement costs were reviewed with WSDOT and ODOT staff and are consistent with bridge costs contained in the WSDOT System Plan and Metro's Regional Transportation Plan Preferred System.

The I-5 Trade Corridor Study will include the development of more detailed cost estimates for a new Columbia River crossing in the I-5 corridor.

HOV bypass lanes for freeway on-ramps were derived by estimating a cost for a new traffic lane with a typical on-ramp distance and a ramp meter signal cost for each location. Similarly, the arterial HOV spot treatments at intersections were given a standard cost for each location where transit priority treatment is was identified.

a) HOV Freeway System

Table 5-2: I-5 Corridor HOV Cost Summary (1998 dollars)

Segment	**Capital Cost** (In Millions)
Going Street to Jantzen Beach	$10
Interstate Bridge Replacement	$400
Interstate Bridge to Main St. Interchange	$3
Main Street Interchanges to 134th St.	$78
Total Capital Cost	$491

I-5 Description

- Add 1 HOV lane each direction Marine Drive to Columbia Blvd. Includes the cost for reconstruction of the southbound structure through Delta Park, converts 1 general travel lane south to Going Street. Note: $2 million cost for northbound lane not added to HOV project cost.

- Interstate Bridge replacement consists of 1 HOV lane, 2 general purpose lanes, and 1 auxiliary in each direction.
- Interstate Bridge to Main Street converts existing general purpose travel lanes to HOV use; include painting, striping, and sign bridges.
- Convert planned general purpose travel lane capacity improvements to HOV use. WSDOT System Plan estimates project cost of $78.2 million for addition of general purpose travel lanes and Main Street and 78th Street interchange improvements. This cost is included in the I-5 HOV cost estimate.

Table 5-3: I-205 Corridor HOV Cost Summary (1998 dollars)

Segment	Capital Cost (In Millions)
I-84 to Marine Drive	$19
Glenn Jackson Bridge	$5
SR-14 to 83rd Street	$38
Total Capital Cost	$62

I-205 Description

- Add 1 HOV lane each direction from I-84 to Marine Drive with inside shoulder.
- Convert inside shoulder of Glenn Jackson Bridge to HOV which consists of shoulder reconstruction, painting, striping and additional overhead sign bridges.
- Add 1 HOV lane each direction from SR-14 to N. E. 83rd Street with inside shoulder.

Table 5-4: SR-14 Corridor HOV Cost Summary (1998 dollars)

Segment	Capital Cost (In Millions)
I-205 to 164th	$30
Total Capital Cost	$30

SR-14 Description

- Add 1 outside HOV lane each direction from SR-14 to I-205 with outside shoulder including additional HOV bypass lane between SR-14 and I-205.
- HOV bypass lane between SR-14 and I-205.

b) Arterial Intersection HOV Costs

Parsons Brinckerhoff conducted the Community Transit Arterial System HOV Study in 1995 and estimated the typical cost of an arterial intersection HOV signal priority treatment. The cost of an HOV arterial treatment can vary widely depending on the technology, hardware installation requirements, the life cycle cost of the system, and any additional costs of modifying an intersection or constructing a bus turnout in conjunction with the signal treatment. Parsons Brinckerhoff estimated that the average cost of signal priority treatment per intersection was $15,000. Assuming an average inflation rate of 5%, the typical intersection cost would be $17,300. This cost does not include intersection improvements that may be needed in addition to the signal preemption treatment. The estimated cost for arterial treatment have been doubled to account for the wide range of uncertainties in capital improvements that may be needed when considering arterial HOV treatment. The HOV System Plan identifies 26 intersections for potential HOV treatment resulting in a total estimated cost of $1 million.

c) HOV Bypass Lane HOV Costs

Cost for HOV lane ramp bypass treatments were estimated using WSDOT's HOV Cost Estimate Worksheet. Within the worksheet, a ramp bypass was identified as a highway lane addition with an average distance of one tenth of a mile. The worksheet estimated lane addition costs at $100,000 per location. In addition, each bypass on-ramp was assumed to have a ramp meter signal at $20,000 per signal, resulting in a total cost of $120,000 for each location. The HOV system plan identifies 16 on-ramps for HOV bypass treatment resulting in a total estimated cost of $2 million.

d) Summary HOV System Plan Costs

The following table summarizes the total bi-state capital cost for the system plan cost estimates described in the previous sections.

Table 5-5: Bi-State HOV Capital Costs

HOV System Plan Element	**Capital Cost** (In Millions)
I-5 HOV	$491
I-205 HOV	$62
SR-14 HOV	$30
Freeway On-ramp HOV Bypass Lanes	$2
HOV Transit Priority at Intersections	$1
Total Bi-state HOV Capital Costs	$586

Significant portions of the HOV improvements for the I-5 and I-205 corridors are within the state of Oregon. In addition, the responsibility for HOV construction on the interstate bridges would be the responsibility of both states. Assuming that HOV improvements on the bridges were split evenly between states, the Washington portion of the HOV system plan would be reduced to $354 million. The following table summarizes the Washington portion of HOV system costs.

Table 5-6: Clark County HOV Capital Costs

HOV System Plan Element	**Capital Cost (In Millions)**
I-5 HOV	$281
I-205 HOV	$40
SR-14 HOV	$30
Freeway On-ramp HOV bypass Lanes	$2
HOV Transit Priority at Intersections	$1
Total Clark County HOV Capital Costs	$354

<u>HOV in the I-5 Corridor</u> - The highest cost element of the system plan is the replacement of the Interstate Bridge spans in the I-5 corridor. There may be potential to develop a low cost option for HOV across the Interstate Bridge, such as reversible contraflow lanes, as a phased approach for HOV in the I-5 corridor, which would depend on results of determining its feasibility. If the Interstate Bridge replacement costs were removed from the Washington portion of the system plan, total cost would be reduced to $154 million. In addition, the I-5 HOV only corridor costs would be $80 million. The feasibility and cost of implementing contraflow lanes on the Interstate Bridge would also need to be addressed.

2. Financing Options for HOV Facilities

This section describes potential federal and state funding sources for which the construction of HOV facilities would be eligible. It includes only those programs that are for multimodal use or that are flexible enough that they could be used for HOV construction. There are no funding programs specifically dedicated for HOV lane construction, with the exception of Core HOV funds, an element of the Washington State Mobility Program, to complete the Puget Sound HOV system.

a) Federal Funding

The passage of the Transportation Efficiency Act for the 21st Century (TEA-21) continues the direction set by the last transportation authorization act passed in 1991. There are several funding categories that could be utilized for the construction of HOV facilities. TEA-21 allows significant flexibility in the way money may be used. There is multimodal emphasis to several of the programs, especially the Surface Transportation Program, that give regions greater independence to invest in alternate modes of travel, including capital transit projects, such as Light Rail Transit (LRT), High Occupancy Vehicle (HOV), and park and ride facilities.

<u>Interstate Maintenance (IM) Program</u> - This program is intended for projects to rehabilitate, reconstruct, restore, and resurface the Interstate System. IM funds may not be used for new travel lanes, other than High Occupancy Vehicle lanes, or auxiliary lanes or reconstruction. Six-year funding is set at $23.8 billion nationwide and $487.9 million for Washington State.

<u>National Highway System (NHS)</u> - National Highway System is a funding category continued from the Intermodal Surface Transportation Efficiency Act of 1991. It establishes a National Highway System (NHS) which consists of major roads in the U.S. including the interstate system; other routes identified for their strategic defense characteristics; routes providing access to major ports, airports, public transportation and intermodal transportation facilities; and principal arterials that provide regional service. I-5 and I-205 are identified as NHS corridors.

Funding in this category may be used for a wide variety of projects. In addition to operational, rehabilitation, and reconstruction improvements, multimodal eligible projects include: fringe and corridor parking, carpool and vanpool projects and HOV lanes. It also allows for road construction and/or operational improvements to roadways that are non-NHS facilities, if the corridor includes an NHS facility, and if the project improves LOS on the NHS facility or is more cost-effective than an NHS project. A transit project in the corridor is also allowed if it benefits the NHS facility. In addition, states have the option to shift 50% of the NHS money to the STP category, which has greater project flexibility. The funding level for the NHS program is $28.6 billion nationwide and $545.7 million for Washington in the next six years.

<u>Surface Transportation Program (STP)</u> - This program is similar to a block grant program and combines the old Federal Primary, Federal Aid Urban, and Federal Aid Secondary categories into a single, flexible, intermodal program. It can be used for any road or bridge except for local or rural minor collectors. In addition to eligibility for operational and capacity improvements to roadways, it allows for the programming of transit capital projects, carpool projects, fringe and corridor parking, capital and operating costs for traffic monitoring, management or control, transportation enhancements, transportation planning, and transportation control measures for air quality.

If an area has been designated a Transportation Management Area, as the Vancouver region has, money cannot be spent on road capacity improvements for general purpose traffic unless the improvements are part of an overall Congestion Management Plan. STP funds can be used for the construction of carpool lanes.

Of the money received by the state, 10% must be set aside for safety projects such as hazard elimination and 10% for transportation enhancements such as pedestrian and bicycle facilities. Total funding for the STP is $33.3 billion nationwide and $877.7 million for Washington State.

<u>Congestion Mitigation and Air Quality Improvement Program (CMAQ)</u> - These funds are specifically targeted for air quality non-attainment and maintenance areas to implement transportation measures intended to improve air quality. The Vancouver area is currently an air quality maintenance area for Ozone and Carbon Monoxide. Eligible measures consist of projects that will contribute to attainment of National Ambient Air Quality Standards (NAAQS) have

been identified by the Department of Transportation or the Environmental Protection Agency. They include transit improvements, shared ride services, traffic flow improvements, demand management strategies, pedestrian and bicycle programs, and vehicle inspection and maintenance programs.

Funds in this category cannot be used for new highway capacity. However, construction of high occupancy vehicle lanes are allowed with the understanding that capacity may be used by single occupancy vehicles during the non-rush hour period. Total six-year funding for this program is $8.1 billion, nationwide. Money in this fund is apportioned by population and weighted by the severity of non-attainment. An average of $21.8 million per federal fiscal year is received for use in areas with air quality problems; Seattle, Vancouver, Spokane, and Yakima. RTC is one of the three MPO's, statewide, in receipt of CMAQ funds.

b) State Funding

The Washington State Highway System Plan for 1999 to 2018 was adopted by the Washington State Transportation Commission in December 1997. The Plan is a component of the Washington Transportation Plan (WTP) and defines the service objectives, action strategies, and cost to maintain, preserve and improve the state highway system over the next twenty years. The estimated cost of highway transportation system needs over the same period is nearly $41 billion. Assuming the past trends for highway funding continue at the same rate of increase into the future, revenues are projected to be only $18.3 billion. Based on these financial constraints, the state has established funding priorities for transportation improvements. The plan identifies maintenance, traffic operations, and preservation activities as the top priorities. Highway safety, environmental retrofit, and economic initiatives, and the Puget Sound Core system of HOV lanes are high priorities. These program needs are almost fully funded within the constrained system plan. Any remaining revenues would go to the highway mobility improvements.

Mobility Program - The objective of the mobility program is to improve mobility within congested corridors. The emphasis of the mobility program is on long range strategies that move people rather than cars. However, in transportation corridors where alternate modes are not viable or available, the existing system could be expanded for general purpose traffic. Long range strategies eligible for funding include: high capacity transit systems, increased bus service, passenger rail, and Transportation Demand Management. Solutions contained in the highway system plan that help accomplish theses strategies are HOV lanes, park and ride lots to support carpooling, traffic flow improvements, and access management.

The Puget Sound region is currently the only area in the state identified in the State System Plan for the construction of HOV lanes. It has 135 miles of HOV lanes in operation now and will add another 170 miles of HOV lanes to complete the core system. The Puget Sound region Core HOV lanes are an element of the Mobility Program fund, but are given higher priority than other elements of the program that add general purpose because they focus on moving people rather than vehicles. Currently, there are no other areas of the state eligible to compete for HOV lane construction through the mobility program. Other regions, such as the Vancouver urban area, that adopt regional HOV goals and policies may also compete for mobility program funds for the construction of HOV lanes.

The next update of the WTP will include the identification of high priority travel corridors within the state. After the selection of high priority corridors, the modal solutions for the corridors will be identified. The adoption of a Clark County HOV System Plan will provide the opportunity to further define modal solutions in Clark County.

State Transportation Fund - The Transportation Fund of the state can be used for any transportation purpose including transit but historically has primarily been used for highway projects. Within the Transportation Fund is the Public Transportation Systems Account, which may be used for transit-related projects, although the amount available to the remainder of the state outside the Puget Sound area is quite small. The fund can be used for the planning, development of capital projects, development of high capacity transit systems, development of HOV lanes and related facilities and provides 80% state funding.

High Capacity Transportation Account - The HCT Account is available to transit and planning agencies for planning, construction, and operating HCT systems and provides 80% state funding.

CHAPTER VI.
RECOMMENDED HOV SYSTEM PLAN

This chapter contains the recommendations of the Clark County HOV Study. These recommendations have three elements: 1) goals and policies of a Clark County HOV System, 2) HOV System Plan, and 3) next steps. The first section summarizes HOV goals and policies. The recommended HOV System Plan is shaped by the goals and policies and is contained in section B. The last section discusses the proposed next steps for a Clark County HOV system.

A. CLARK COUNTY REGIONAL HOV SYSTEM GOALS AND POLICIES

These HOV System goals and policies are intended to meet our region's unique travel needs and define the role of HOV in the Clark County region. This section summarizes the key goals and policies; the full description of Clark County HOV goals and policies are contained in chapter III of the report. They are also consistent with the adopted policies of the Washington State Department of Transportation (WSDOT) which allow a region to compete for statewide funding for the engineering, design or construction of HOV facilities. If our region decides to construct HOV facilities, these policies would guide the development of the system.

1. HOV System Goals

The regional HOV system goals described below are consistent with state policies and address our region's unique needs for freeway and arterial HOV facilities. Overall, it is the region's policy to implement HOV facilities in the most congested corridors that will benefit transit and carpool users by providing reliable travel times savings for shared vehicles to bypass single occupant vehicle congestion. The proposed goals for an HOV system in Clark County are to:

- Improve mobility for persons and freight by emphasizing person carrying capacity over vehicle carrying capacity of our major transportation corridors.
- Give priority to shared ride commute trips occurring during the peak period to manage congestion by improving efficiency and use of transportation corridors.
- Ensure bi-state coordination on the HOV system and its operations across interstate facilities.

2. Freeway HOV System Policies

These HOV policies are intended to define the purpose of HOV facilities in our region and their role as a transportation strategy. They provide for the management of freeway transportation corridors through the development of HOV facilities that address recurring congestion, traffic bottlenecks, and incident management. The freeway HOV policies state that:

- HOV lane facilities shall be implemented in transportation corridors where congestion levels are high and where the potential for travel time savings for bus or carpool persons are significant.
- HOV support programs and facilities, such as carpool/vanpool programs, express bus service, and park and ride facilities, shall be in place or planned for any transportation corridor being considered for HOV use.
- The long-range goal for the implementation of freeway HOV facilities is through added capacity to accommodate HOV. A phased approach for implementing a long-range strategy will consider the conversion of existing or planned general purpose travel lanes for HOV use.

- The long-term management of HOV lane demand will include maintaining the option for future conversion of the HOV lane to high occupancy toll lane.

3. Freeway HOV Operating Policies

Before implementing an HOV facility, operating policies must be adopted jointly by the WSDOT, RTC, C-TRAN, local governments, the Washington State Patrol, general freeway users and the freight and environmental community. Operating policies should:

- Include a speed and reliability standard to ensure that HOV facilities will continue to provide a reliable travel time advantage compared to general purpose travel lane.
- Maintain consistency with adopted state policy regarding occupancy requirements, hours of operation, inside versus outside lane operation, and enforcement.
- Provide for public review and comment on HOV proposals or changes.

The freeway HOV operating characteristics of the system plan will form the basis for a more comprehensive development of operating policies for a Clark County HOV system.

4. Arterial HOV System Policies

Arterial HOV policies, as an element of an HOV system, must complement freeway policies to promote bus movement and transit reliability by establishing priority for transit person travel.

- Arterial HOV facilities provide preferential treatment to buses through improved access onto a freeway HOV facility and will provide transit priority at locations along arterial corridors where there are high bus volumes, significant congestion points, bottlenecks, or failing intersections.

B. CLARK COUNTY HOV SYSTEM PLAN

The policies described in the previous section have guided the development of the HOV system plan shown in Figure 6-1. The HOV system includes a number of elements that work together to accomplish HOV system goals. They include freeway, arterial, support facilities as well as definition for the operational characteristics of the HOV system. The system plan represents a long-range alternative for Clark County.

1. Freeway Facilities

The freeway facilities form the spine of the HOV system and provide high quality service for shared ride commuters traveling to their major destinations. HOV bypass ramps give priority access to shared ride vehicles onto the freeway and work in conjunction with the freeway HOV lanes.

The next section describes the HOV characteristics for each of the recommended freeway corridors and their ramp bypass locations.

I-5 HOV Corridor

- 134^{th} Street to the Main Street Interchange - Add one lane of new capacity for HOV.
- Main Street to Interstate Bridge - Convert existing inside general purpose travel lane for HOV use.
- Interstate Bridge - New Columbia River bridge with one additional lane of capacity for HOV.
- Marine Drive to Columbia Boulevard - Add one lane of capacity for HOV use.
- Columbia Boulevard to Going Street - Convert existing general purpose travel lane to HOV use.
- Ramp bypass for HOV priority access would be located at 134^{th} Street, 78^{th} Street, 99^{th} Street, Main Street, Fourth Plain Boulevard, and Mill Plain Boulevard.

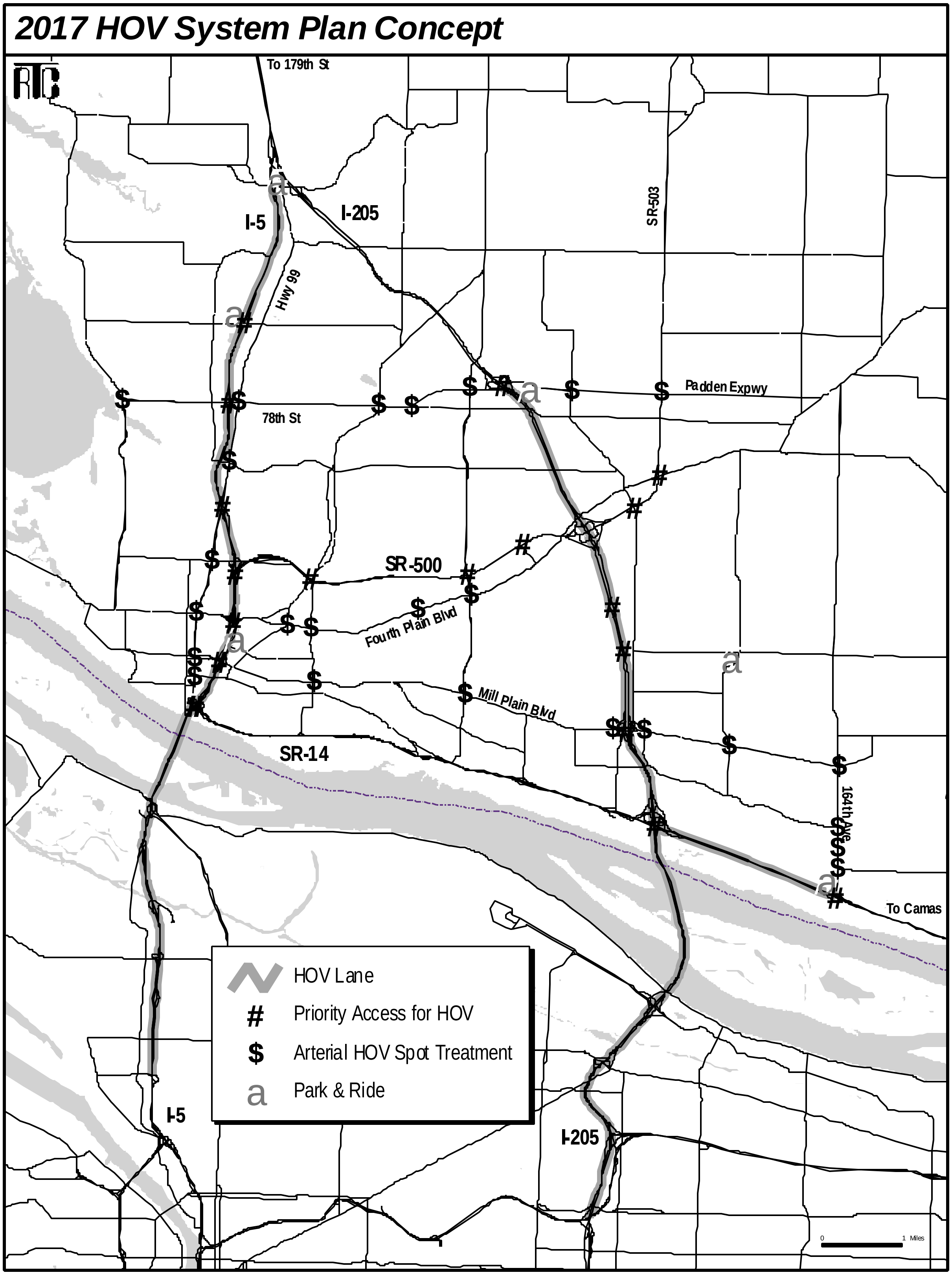


Figure 6-1: 2017 HOV System Plan

I-205 HOV Corridor

- 83rd Street to Glenn Jackson Bridge - Add one lane of new capacity for HOV.
- Glenn Jackson Bridge - Add an HOV lane by taking the inside shoulder.
- Glenn Jackson Bridge to I-84 - Add one lane of new capacity for HOV.
- Ramp bypass for HOV priority access would be located at 83rd Street, 18th Street/28th Street, and Mill Plain Boulevard.

SR-14 HOV Queue Bypass Corridor

- I-205 to 164th Avenue - Add outside lane HOV lanes from I-205 to 164th Avenue as a queue bypass lane for traffic destined to I-205 south.
- Ramp bypass for HOV priority access would be located at 164th Avenue, Ellsworth Road, Lieser Road, Evergreen Boulevard, and Grand Boulevard.

SR-500 HOV Ramp Bypass Corridor

- I-5 to I-205 - Ramp bypass for HOV priority access at Andresen Road/Thurston and St. John's Road.

2. Arterial HOV Facilities

This section describes the arterial components of an HOV system and the locations where arterial HOV treatment is recommended. The purpose of an arterial HOV is twofold: 1) to improve access to the HOV freeway system, and 2) to support transit priority on the arterial system. The arterial HOV system is intended to promote bus movement and improve transit reliability by giving priority to the movement of transit vehicles in congested arterial corridors

164th Avenue **-** Bus priority treatment at Mill Plain Boulevard, McGillivray Boulevard, SE 29th Street, and SE 34th Street.

Washington/Main Street and Highway 99 - Bus priority treatment for all signalized intersections along the corridor from 7th Street to 78th Street.

Andresen Road **-** Bus priority treatment at 63rd Street and 78th/Padden Parkway intersections with Andresen Road.

Fourth Plain Boulevard - Bus priority treatment for all signalized intersections at Fort Vancouver Way, Grand Boulevard, Stapleton Road/54th Avenue, Andresen Road, and Thurston Way. Other intersections should also be considered.

Mill Plain Boulevard **-** Bus priority treatment at Grand Boulevard, Andresen Road and all signalized intersections from 104th Avenue to 164th Avenue.

134th Street (Park and ride access to I-5 on-ramp) - Provide bus priority treatment between park and ride lot and traffic signals to I-5 on-ramp entrance.

Padden Parkway (Park and ride exit to I-205 on-ramp) **-** Provide bus priority treatment exiting park and ride lot to left turn to Padden Parkway and at traffic signals to I-205 on-ramp entrance.

164th Avenue (Park and ride access to 164th) **-** Signal priority for busses between park and ride access and 164th.

3. Transit HOV Facilities

Transit HOV facilities are a critical component of the HOV system, and there are a number of activities underway in the region today. The purpose of this section is to recognize that these facilities play an important role in the success of an HOV facility. At this point the system does not recommend new projects or programs, but it does recommend that the current and planned facilities and programs continue and grow to provide support to the HOV system.

Transit Service - C-TRAN currently provides extensive commuter express service in both bi-state corridors with 17 buses in I-5 and 10 buses in I-205 during the peak hour. In 2017, planned improvements call for 28 buses in I-5 and 21 buses in I-205.

Park and Ride - The primary park and ride lots providing bi-state transit service from Clark County to Portland are the Salmon Creek and Evergreen park and ride facilities. Over the next three to four years, new park and ride facilities are expected to begin operation. The Evergreen park and ride is scheduled for expansion in the near future. Fisher's Landing park and ride and will open in the year 2000. A park and ride lot is also being considered at 99th Street and I-5 and could open by the year 2002. In addition, the planned Central County park and ride near I-205 would be constructed adjacent to Padden Parkway.

There are also several programs in the region directed by C-TRAN that complement an HOV system. They include the Commute Trip Reduction program, the Vanpool program, and the CommuteMatch program.

4. Freeway HOV Operations

This section describes the operational characteristics of the HOV system plan. The freeway HOV operations will be the foundation for the final adoption of freeway HOV operating policies prior to the implementation of HOV facilities.

Hours of Operation - The Clark County HOV system would operate on weekdays for three hours in the A.M and three hours in the P.M. Hours of operation would be determined by analysis of directional peak period traffic conditions in the corridor. Opening the HOV capacity to general purpose use during the off-peak period would benefit midday traffic operations in the I-5 corridor for all users of the transportation system.

Occupancy Requirements - Occupancy requirements would be set at two or more people per vehicle. A three or more requirement would be considered if the speed and reliability standard was not met.

Operating Standards - Operating standards set speed and reliability benchmarks for the HOV lane and would be the same as state policy for the Puget Sound Core HOV system. State policy for HOV freeway operating standards state that the HOV lane must "maintain or exceed an average speed of 45 m.p.h. or greater 90% of the times that they use the lane during the peak hour".

C. SUGGESTED NEXT STEPS

A series of suggested next steps are proposed as a part of the overall HOV system plan that would 1) provide the opportunity for a short-term consideration of an HOV facility in the I-5 corridor and 2) address remaining elements of the HOV System Plan where there are currently no programmed improvements.

1. I-5 Corridor

The initial series of next steps are directed at the further examination of opportunities for HOV implementation in the I-5 corridor. There are short-term highway improvements programmed to add roadway capacity in the I-5 corridor north of Main Street. These highway improvements could be modified for HOV use if an HOV facility is pursued in the I-5 corridor. C-TRAN has plans for expanding commuter transit service and park and ride capacity in the I-5 corridor which would also support the HOV plan. In addition, the HOV system study has shown that I-5 has the highest levels of traffic congestion, offers the most HOV travel time savings, has the highest carpool utilization, and the highest transit demand.

Before moving ahead, the I-5 HOV proposal would require a feasibility analysis which would consist of two primary tasks. The first would include the development and analysis of alternatives to determine the feasibility of providing additional HOV lane capacity across the Columbia River without replacing the Interstate Bridge. The second task would be a corridor traffic operations and traffic flow analysis to assess the HOV lane and its impact to the adjacent general-purpose travel lanes.

Further consideration of HOV in the corridor would depend on the results of the feasibility analysis and two key decisions: 1) the addition of HOV capacity across the Interstate Bridge and 2) the addition of a southbound HOV lane in Oregon in the vicinity of Delta Park. The next step would be to develop a conceptual design for an HOV facility in the I-5 corridor. For example, the design would include the Interstate Bridge, HOV lane treatment north and south of the bridge, and enforcement areas. The final major element of the implementation plan would consist of a public information effort to engage community opinion in regard to an HOV facility in the corridor.

New park and ride capacity and expanded transit service in the I-5 corridor are also part of the consideration of HOV in the corridor. The park and ride lot under consideration at 99th Street and I-5 could open by the year 2002 and would provide additional commuter service to Portland. A new park and ride facility was recently opened at BPA in conjunction with the northbound HOV pilot project on I-5 and would also support an HOV facility in the corridor.

2. Other HOV System Plan Elements

The implementation of the system plan relies on future decisions affecting the transportation system where there are currently no programmed activities in the next six years. The other system plan elements include I-205 HOV improvements, additional bus service, arterial HOV improvements, HOV ramp bypass treatments, and a decision on the replacement of the Interstate Bridge. HOV policies will guide the development of priorities for the implementation of the system plan. Other system plan elements will be coordinated with transportation future policy decisions regarding high capacity transit in the region. In addition, the sequencing of improvements contained in the system plan will be determined through coordination among the affected jurisdictions based on levels of congestion and system need.

I-205 - Add an additional traffic lane for inside lane HOV along the length of the corridor from 83rd Street/Padden Parkway to I-84.

Improved Bus Service - Continue improvements to C-TRAN commuter service to increase transit ridership between Vancouver and Portland.

Arterial HOV Improvements - Coordinate with C-TRAN to establish priority intersections for implementing preferential treatment for buses at congested intersections.

HOV Ramp Bypass - Work with WSDOT to identify locations for HOV ramp bypass based on congestion and potential improvement to freeway operations.

Interstate Bridge - Evaluate options for providing additional capacity for HOV in the I-5 corridor across the Columbia River including the construction of a new bridge and decide on the preferred river crossing alternative.